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THE
BRITISH JOURNAL OF PSYCHOLOGY
MONOGRAPH SUPPLEMENTS, VOLUME I

II
OBLIVISCENCE
AND
REMINISCENCE

by
PHILIP BOSWOOD BALLARD, M.A.



Cambridge University Press

C. F. CLAY, Manager

LONDON: Fetter Lane, E.C.

EDINBURGH: 100, Princes Street

also

H. K. LEWIS, 136, Gower Street, London, W.C.

WILLIAM WESLEY & SON, 28, Essex Street, London, W.C.

BERLIN: A. Asher and Co.

LEIPZIG: F. A. Brockhaus

CHICAGO: The University of Chicago Press

BOMBAY AND CALCUTTA: Macmillan and Co., Limited

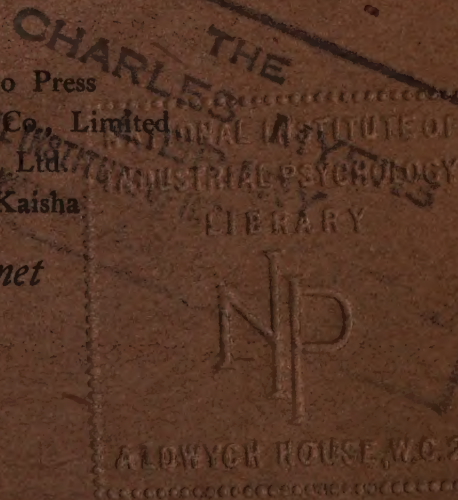
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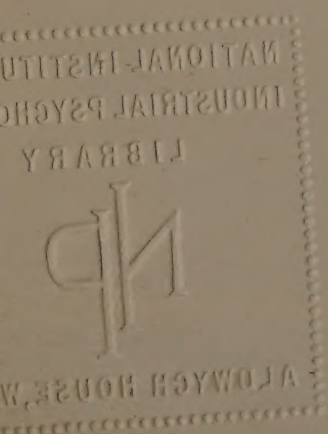
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PHILIP BOSWOOD BALLARD, M.A.

Cambridge
at the University Press

1913

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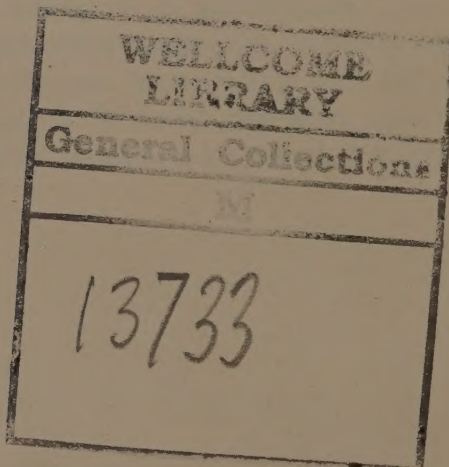
REMINISCENCE

PHILIP ROSSWOOD BATHURST, M.A.

Cambridge :

PRINTED BY JOHN CLAY, M.A.

AT THE UNIVERSITY PRESS



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PREFACE

THERE is probably no field of psychological inquiry which has been more assiduously explored than that of memory; and yet the particular aspect of memory with which this monograph deals has received but the scantiest attention. Reminiscence, or the remembering again of the forgotten without re-learning, occurs frequently in everybody's life: in the lives of children it plays a far more important part than most of us suspect. There is need therefore for some such investigation as is here attempted.

The material memorised has mainly, but not exclusively, consisted of ballad poetry; and this, on account of its variety and complexity, is open to obvious objections. But these objections are counterbalanced by certain solid advantages. The learning of poetry forms part of the curriculum of every school, and the experimenter need have no fear of failing to secure the sympathy and co-operation of the teacher. If simpler material is used, better though it be for pure purposes of investigation, the teacher may justly urge as an objection that the abandonment of the theory of formal memory training demands that the material memorised should be valuable for its own sake. In learning nonsense syllables a sacrifice of time and energy on the part of the children is necessarily involved. With poetry, however, as the material used, it has been found possible to extend the experiments over a very large field, and it is hoped that from the great number of experiments made general laws will be found to emerge as clearly as they would have done had the tests been carried out under the more stringent conditions of the psychological laboratory.

It is manifest that the numerous and extensive experiments described in this treatise could not have been carried out without the hearty co-operation of the teachers in the schools concerned; and I herewith

acknowledge my deep indebtedness to a large number of teachers, both head and assistant, in the elementary schools of South-East London.

I must further record my obligations for the help of the following teachers engaged in higher education: Miss C. C. Graveson, Miss M. Collins, Mr Evan Davies, Dr Emys Jones, and Dr E. O. Lewis.

Finally I wish to thank Dr C. S. Myers for his kindness in reading the manuscript and making certain criticisms and suggestions which proved extremely helpful.

P. B. BALLARD.

DULWICH,

October, 1913.

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OBLIVISCENCE AND REMINISCENCE

Introduction

It is generally believed that when one attempts to memorise a passage of poetry the power to reproduce it is at its greatest immediately after. Thenceforth the power is supposed to undergo a gradual process of decay; and it is assumed that the longer the lapse of time between the act of learning and the act of reproduction, the more difficult and the less accurate is the reproduction likely to be. And, speaking generally, whatever may be the nature of the traces left in our minds by our experiences, those traces gradually fade, and the curve of remembering has but one tendency—a downward tendency. Allowing for certain fluctuations in memory due to ill-health and fatigue, it will readily be admitted that the strongest and most general tendency among our unrevived memories is this tendency towards oblivion. They are less and less easily reproducible. But this is not the only tendency. Obliviscence is at least partly counteracted by an opposing tendency towards reminiscence. We not only tend to forget what we have once remembered, but we also tend to remember what we have once forgotten. And although we associate reminiscence, in the loose and popular sense of the word, with old age, in the strict sense of the word in which it is here used—in the sense of remembering the forgotten—it is really more characteristic of the young. At least it is so when it refers to recently acquired knowledge. When a child has memorised, say, a piece of poetry, and has dismissed it from his mind, the period of gradual forgetfulness is as a rule preceded by a period of gradual improvement. And the object of this monograph is to present and discuss evidence as to the nature and extent of this recuperative aspect of memory, this increase in reproducibility, this power which not merely arrests the passage of our memories towards forgetfulness, but drives them back towards ready and accurate recall.

An example of the Improvement of Memory without further learning.

My attention was first drawn to Reminiscence in this way. The children in a certain slum school were alleged to have very bad memories: it was said that they could learn but little, and what little they learnt they could not retain. I tested this statement by setting the top class of boys, whose average age was 12 years and 10 months, to memorise Cowper's "Loss of the Royal George." They were allowed 13 minutes, and at the end of that time the books were collected and the boys were asked to write out as many lines as they could remember. After setting aside and leaving out of account the boys who were in any way familiar with the poem, 19 remained as subjects of the experiment. Only one boy was able to write out the whole of the 36 lines, and the average number of lines for the class was 27·6. After two days' interval I again tested the boys. They were asked to write out all they remembered then. Neither teacher nor scholars expected this second test and no opportunity was given for revision. Much to the teacher's surprise, 8 of the boys wrote out the whole poem correctly, and the average number of lines correct was 30·6—an increase of more than 10 per cent. over the previous number. Out of the 19 boys none had deteriorated and 16 had improved. This result seemed to be so remarkable that I set a similar test in several other types of schools, and always with the same result. After two days' interval more was remembered than immediately after learning. A crowd of questions immediately arose. Was the improvement due to the fact that the poem was accessible and was studied in the interval? Was it true of all children or only of children of about 13 years old? Did the same law hold good for both boys and girls? Was two days the most favourable interval? When did the ability to recall begin to decline? How far was it dependent on the nature of the poem? Was it conditioned by the method of learning, or by the sense involved? How was it related to other forms of mental ability?

An experiment in memorising "The Ancient Mariner."

To solve some of the most important of these problems it was desirable to find a piece of poetry which was not to be found in the anthologies of verse used in the schools, and which was not beyond the comprehension of the children. I selected from Part II of "The Ancient Mariner" 34 lines which seemed to satisfy these conditions. This test

was set in 42 senior departments of elementary schools. As a rule the highest three classes alone took part, the total number being 128, of which 58 were boys' classes, 61 girls', and nine mixed. Altogether 5192 children were involved. Each experiment necessitated two tests, one immediately after memorising, and the other after an interval of one or more days. I propose to call the first of these the primary test, and the second the secondary test. In some of the schools the experiment was made with one day's interval between the pair of tests, in others with two days' interval, in others with three days' interval, and so on up to seven days. If the secondary test was to be totally unexpected on the part of the children, it was obviously impossible to repeat the experiments in the same school. Hence the large number of schools selected. Care was taken to associate different types of school with each time interval. If for instance one of the schools chosen for the three days' experiment was attended by a particularly good class of children, another school was selected where the children were particularly poor. An attempt was thus made to secure a fair average result for London children. The same method of procedure was adopted throughout. Each child in the class was provided with a typed copy of the extract from "The Ancient Mariner." It was read over to them once, and they were then given 15 minutes to learn it. At the end of the 15 minutes the papers were collected and the children required to write out all they could remember. This was the primary or learning test. Without being told that they would be again tested, and without being given an opportunity for revision, they were asked after the prescribed interval to write out the piece again. This was the secondary or retention test. The results of the two tests were then compared. In marking, only those lines which were absolutely correct were counted. No note however was taken of sequence: the lines considered correct were not necessarily consecutive.

It may be said here that in all these experiments the utmost precaution was taken to prevent children gaining access to the poem in the interval between the two tests, or even suspecting that a second test would be given.

Taking the total results the average number of lines reproduced immediately after memorising was 12·2 for boys, and 15·5 for girls, and nearly 14 for both combined; and this initial number remained fairly constant for the seven intervals. When however the results of the secondary tests were considered, it was found, as was expected, that the numbers varied with the lapse of time between the two tests.

After an interval of 1 day there was a loss of 1·6 per cent.					
„	„	2 days	„	gain „	9·4 „
„	„	3 „	„	„ „	6·1 „
„	„	4 „	„	loss „	2 „
„	„	5 „	„	„ „	5·8 „
„	„	6 „	„	„ „	8·7 „
„	„	7 „	„	„ „	12·1 „

These percentages were arrived at by taking the total number of lines written after the given interval by all the children who took part in that particular experiment, and comparing it with the total number written by the same children immediately after memorising. The result for the one day's interval does not mean that every child, nor even every class, remembered less; nor does the result for the two days' interval mean that every child remembered more. This will be made clear by Table I.

TABLE I. "*The Ancient Mariner.*"

Interval	Number of		Percentage of children who after the interval remembered		
	classes	children	more	the same	less
1 day	15	644	45·5	14·9	39·6
2 days	21	841	55·3	13·9	30·8
3 „	16	646	47·5	13·3	39·2
4 „	25	1086	40·6	15·1	44·3
5 „	15	657	42·2	13·1	44·7
6 „	17	660	30	14·1	55·9
7 „	19	658	28·4	13·4	58·2

Altogether 5192 children took part in the experiment, and of these 2168 were able to write out more lines after the interval than before, 730 wrote the same number, and 2294 wrote less. It will be observed that while the number who remembered the same amount remains fairly constant for the whole of the seven periods, the number of those who remembered more varies with the interval, and follows generally the same tendency as the percentages of improvement referred to above, as will be readily seen by references to Charts 1 and 2. The fact that about half the children in a class improve indicates clearly that the general improvement is not due to 'freak' memories on the part of a few children. Indeed evidence will be given later on to show that the tendency to improvement is almost universal.

The reader is now invited to study the curve for "The Ancient Mariner" as set out in Chart 1. The abscissae represent time intervals, and the ordinates the percentages of lines reproduced, taking as the

standard the number reproduced at the primary test. It will be seen that the crest of the 'memory curve' (as it may be called) appears at the end of the second day. I have worked out the results separately for boys and girls, but there is no important difference between them, except that in the case of the girls a slight gain is indicated at the end of the first day. It is not improbable that more extended experiments would have revealed a general gain with boys also. In fact four of the nine classes of boys were able to repeat more.

The results in the different classes were by no means uniform for the same interval (some of the causes of divergence will be discussed later); nor was there invariably a gain or a loss. For instance, for the more

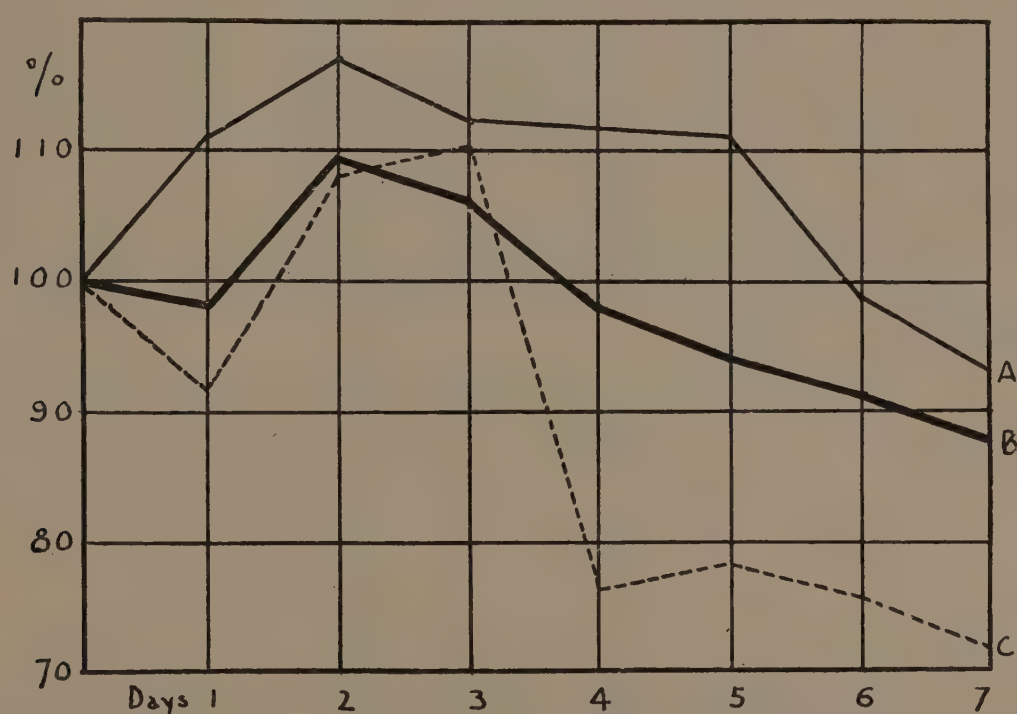


Chart 1. Memory curves of children about 12 years of age. The amount remembered immediately after learning is taken as the basis on which the percentage reproduced later is calculated. A. "The Wreck of the Hesperus." B. "The Ancient Mariner." C. Nonsense Verses.

favourable interval (two days) two classes out of 21 showed a loss, and for the least favourable interval (seven days) two classes out of 19 showed a gain. There were two classes (one with two days' interval and the other with three) where no pupil lost ground, and two classes (all with seven days' interval) where no pupil gained ground.

In studying the various charts it must be borne in mind that for each interval there is a separate primary test. The result for a seven days' interval, for instance, does not indicate what takes place when the

subject learns a passage of poetry and is tested immediately, then again on the next day, and again on the following day, etc. for a week ; but it indicates what happens when the subject is tested immediately after learning, and is not tested again until a week has elapsed.

Improvement varies with the Poem memorised.

The results obtained by using "The Ancient Mariner" were not so striking as those obtained with poems which made a stronger appeal to the pupil's interest. Further experiments were made with "The Wreck of the Hesperus," or, where any of the children were familiar with that ballad, some other poem of similar interest and difficulty. The time allowed was ten minutes. Taking the results as a whole the average number of lines reproduced immediately after memorising was 15. While the children could not learn "The Ancient Mariner" quite at the rate of a line per minute, they were able to learn "The Wreck of the Hesperus" at the rate of a line and a half per minute. Fewer classes were taken for this supplementary test, but they were chosen as representing children of normal ability in general school work. The results were as follow :

For an interval of 1 day there was a gain of 11 per cent.					
"	"	2 days	"	"	17.2 "
"	"	3 "	"	"	12.5 "
"	"	4 "	"	"	11.9 "
"	"	5 "	"	"	11.1 "
"	"	6 "	"	loss of	1 "
"	"	7 "	"	"	6.3 "

It will be clearly seen by looking at Chart 1 how the curve for "The Wreck of the Hesperus" compares with that for "The Ancient Mariner." The curve is considerably broader and higher, although it preserves nearly the same shape. One reason for its increased height is to be found in the fact that there was a wider margin for improvement among the best memorisers. Only 34 lines of "The Ancient Mariner" were set, and 15 minutes allowed. Some few children memorised the whole and were able to reproduce it correctly. This afforded no room for improvement: any change that took place would necessarily be deterioration. "The Wreck of the Hesperus" on the other hand contains 72 lines, and nobody was able to learn the whole in the 10 minutes allowed ; although one boy learnt 46 lines, which he increased to 49 after two days, and another boy improved from 44 to 50. But this only partly accounts for the difference, for the number of children who reached

the upper limit in "The Ancient Mariner" was very small. How else then is the difference to be accounted for? My first hypothesis was that it was a matter of meaning: the more meaningful the poetry was to the learner the higher would be the memory curve. To test this hypothesis I set the following Nonsense verses to a few selected classes:

Inka rima rinka ro,
Banim bokie salib so,
Bick bock, sec sim,
Thigger thogger donner dim.

Billin fimpol en sol mun,
Sarn il wotlip discol dun,
Flom flam, sen mol simp,
Disper bo rin sopper timp.

Som lep raccal nes lo tad,
Beslo delpit fixil nad,
Tamp rilc, lectom bish,
Entoc riplam in sal rish.

As the learning of Nonsense verses would involve unprofitable labour on the part of the children I did not feel justified in setting the test to a large number. The conditions of the test were similar to those imposed in the case of "The Ancient Mariner" except that the time allowed for learning was 10 minutes instead of 15 minutes. The lines were not readily learnt, the average number initially memorised by the boys being 2.5 and the girls 2.7. The percentage improvements for the seven days were

— 8, 8.7, 10.1, — 23.7, — 21.4, — 24, and — 27.7, respectively.

A study of Chart 1 will reveal respectively the points of resemblance between the curves for "The Wreck of the Hesperus," "The Ancient Mariner" and Nonsense verses. In the third of these curves the dip at the end of the first day is emphasized and the descent after the third day is much more rapid. The degree of improvement however for an interval of three days is greater than for "The Ancient Mariner." This result disposes of the theory that improvement is due to the extent to which the lines are loaded with meaning. It however points, as one would naturally expect, to the importance of interest in determining the character of the curve of remembering.

In order to throw more light on the nature of these results I subjoin tables indicating the scope of the experiment and the percentage of subjects who improved. The corresponding table for "The Ancient Mariner" has already been given.

TABLE II. "The Wreck of the Hesperus."

Interval	Number of		Percentage of children who remembered		
	classes	children	more	the same	less
1 day	7	287	58.2	15.7	26.1
2 days	20	681	75.0	10.0	15.0
3 "	4	174	58.0	10.4	31.6
4 "	15	595	50.4	18.1	31.5
5 "	3	118	57.6	11.0	31.4
6 "	2	56	44.6	14.3	41.1
7 "	3	123	31.7	22.0	46.3

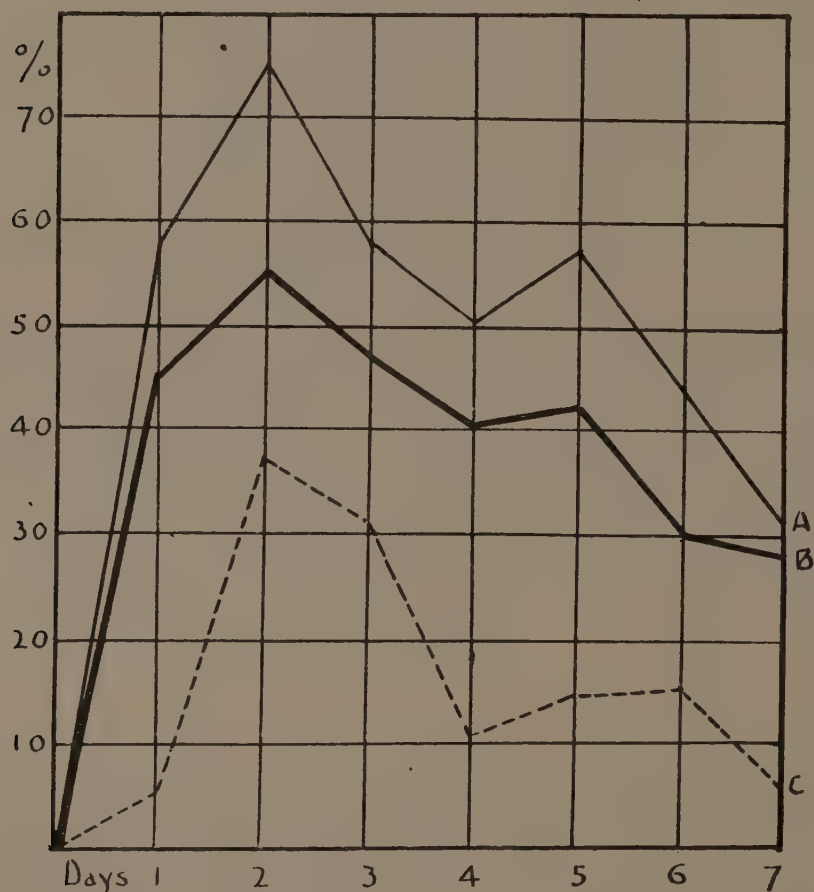


Chart 2. Percentage of children whose memories improved with the lapse of time.
A. "The Wreck of the Hesperus." B. "The Ancient Mariner." C. Nonsense Verses.

TABLE III. Nonsense Verses.

Interval	Number of		Percentage of children who remembered		
	classes	children	more	the same	less
1 day	1	36	5.6	63.9	30.5
2 days	3	131	37.4	41.2	21.4
3 "	5	162	31.5	42.6	25.9
4 "	1	37	10.8	37.8	51.4
5 "	1	33	15.1	18.2	66.7
6 "	1	44	15.9	40.9	43.2
7 "	1	32	6.2	28.1	65.7

The results are graphically represented in Chart 2. It will be noted that under favourable circumstances three-fourths of the children show improvement at the end of the second day, and that even with uninteresting material some children show improvement at the end of a week.

Why should the memory curve for "The Wreck of the Hesperus" be higher than for "The Ancient Mariner"? "The Wreck of the Hesperus" contains a simple and complete story of adventure. The sequence of events is natural and convincing. The sentiment is in no way above the comprehension of the children. Here are distinct points of advantage over "The Ancient Mariner" as a poem for children. The important issue is that although interest and intelligibility seem to determine the height of the curve they seem to have but little influence over its general shape. Considerable improvement in reproducibility takes place too when very uninteresting material is dealt with.

Improvement varies with the Age of the Subject.

It will be observed that so far the experiments have been confined to children of from 11 to 14 years old. When however the experiments were extended to subjects differing widely from these in the matter of age, very marked differences were revealed in the memory curves. In the case of young children of from five to seven years the degree of improvement is much higher than with older children; whereas in the case of adults there seems to be no improvement at all. Indeed the characteristic seems gradually to disappear with age.

I will first describe the experiments with infants. In dealing with the children in the senior school it was necessary to take precautions so that the subjects did not suspect a second test; hence, as a rule (there were exceptions), the experiment was not repeated with the same children. But with infants such precautions were scarcely necessary; for but few of them could read the poems memorised, and they are not accustomed to anticipate tests. They are more inclined than their elders to live from hour to hour, taking no thought for the morrow. The same children were accordingly concerned in six distinct experiments, except in cases of absence from one or more of the tests. These children attended two different schools, three classes being selected in one school and four in another. The method of memorisation necessarily differed from that adopted with the senior children. The poem was read out by the teacher, and occasionally repeated by the class, for twenty minutes.

As a rule only about ten or twelve lines were taught, and the children were tested by individual and private oral repetition. The intervals between the pairs of tests varied from one day to six. The poems selected depended upon the ages of the children, the older being given such verses as "Wynken Blynken and Nod," or some of Stevenson's poems for children, and the younger ones somewhat simpler rhymes. There was some difficulty in keeping the lines for the different intervals of equal interest and memorableness; and the attempt seems to have been most successful when different verses of the same long poem were used. "Meddlesome Matty," for instance, was found useful for this purpose. Continuous passages of this kind were not however found to be so successful in the senior departments.

TABLE IV. *Infant Schools.*

Interval	Number of		Percentage of children who remembered		
	classes	children	more	the same	less
1 day	7	288	75.0	21.5	3.5
2 days	7	282	86.5	11.7	1.8
3 "	7	274	88.7	10.2	1.1
4 "	7	246	88.6	8.5	2.9
5 "	7	236	75.0	14.4	10.6
6 "	7	250	55.6	18.4	26.0

The total number of children engaged in this series of tests was 307, but at each pair of tests several were absent. Only one child was found who did not improve for at least one of the six intervals. The number of improvers would indeed have been larger but for the fact that many of the children could repeat all the lines at the primary test and had no opportunity to show their capacity for improvement. For the same reasons the total degree of improvement in the number of lines repeated, as represented below, would probably have been higher if the children had been given more lines to learn.

The total percentages of improvement for the six days were

37, 56.6, 60, 58.6, 41.7, and 21.8, respectively.

The curve is plotted in Chart 3. It will be seen that it is much higher and broader than for older children. It is indeed not easy to say where it ends.

An entirely independent series of tests was set at an Infant School where the children had had much practice in learning poetry. The interval for each class was 14 days. For so long an interval the results are striking. (See Table V.)

TABLE V. *Infant School. 14 days' interval.*

Class	Age	Number in class	Percentage of	
			improvement	improvers
1	7	56	17·8	76·8
2	7	43	10·3	44·2
3	7	30	66·7	93·3
4	6	47	34·3	76·6
5	5	30	97·4	96·7

The average number of lines initially learnt was 5·5. I have also worked out these results separately for boys and girls, and it is interesting to record that the girls learnt a little faster than the boys, but the boys showed somewhat greater improvement. The average number of lines

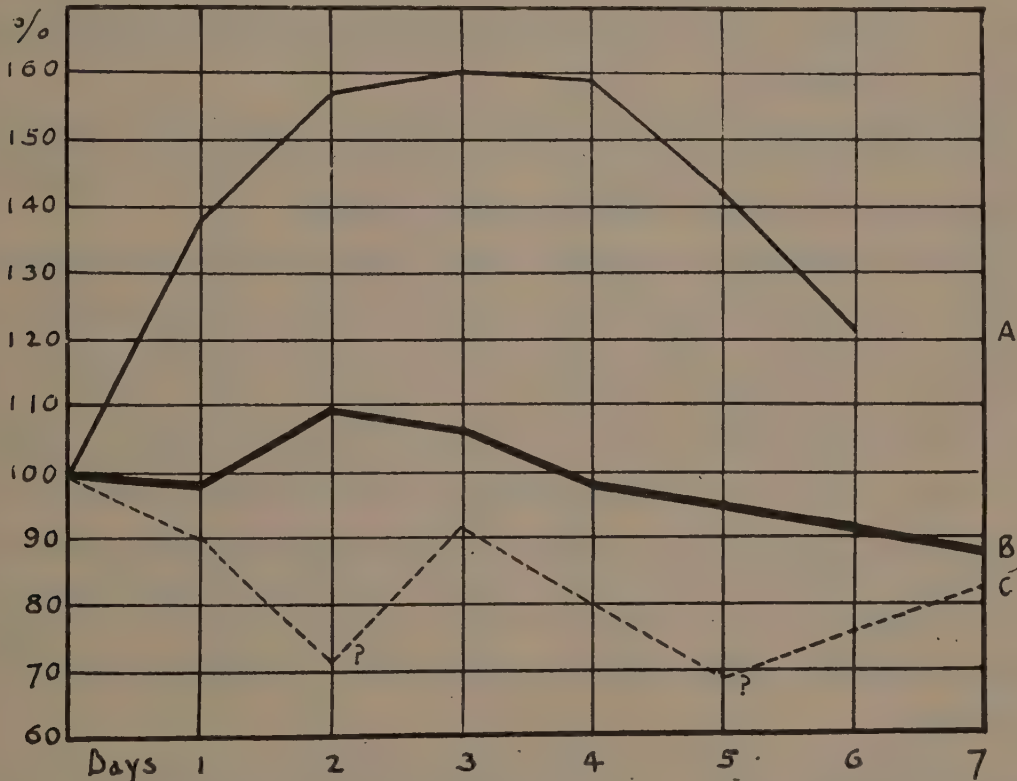


Chart 3. Memory curves for subjects of different ages. A, about 6 years old; B, about 12; and C, about 21. The query marks indicate a small number of subjects (see Table VIII).

initially learnt by the boys was 5, and by the girls 5·9. The boys showed 31 per cent. improvement and 76 per cent. of improvers as against 29·9 per cent. and 74·5 per cent. respectively for the girls. The difference however is too slight to be of much significance.

It is remarkable that only 6·3 per cent. of the children were found to deteriorate at the end of the fortnight. There is little doubt however that the figures are exceptional, for the school, as already indicated, devotes an unusual amount of attention to the memorising of verse.

The retentiveness of these children was so surprising that another infant school of a different character was tested under similar conditions. The results are given in Table VI.

TABLE VI. *Infant School. 14 days' interval.*

Class	Age	Number in class	Percentage of	
			improvement	improvers
1	7	33	39·8	60·6
2	7	37	89·0	97·2
3	6	34	8·2	38·5
4	6	42	6·8	33·3
5	5	43	24·4	44·2

These results, remarkable enough in themselves, are not so good as in the previous school. Nor is the number of lines initially learnt so high, being 3·1 as against 5.

There remains the outstanding fact that young children possess a remarkable degree of mnemonic recovery, and that it is a quality so common among them as to be practically universal.

At first I doubted the fairness of the comparison between the results for younger and older children on account of the dissimilarity in the modes of procedure. The poetry was learnt differently and tested differently. Accordingly I submitted a class of 46 boys, of an average age of 12 years and 10 months, to a test in which the poem was learnt in the same way as in the infant school, that is, entirely by ear. Twenty lines of "The Wreck of the Hesperus" were repeated by the teacher for 20 minutes. After an interval of two days the boys showed an improvement of 15·8 per cent., which is somewhat below the average. The percentage of improvers however was 76·1, which is a little above the average.

The different methods of learning fail therefore to account for the difference between the results for infants and for senior children. Experiments in testing seniors orally instead of in writing are not equally conclusive. Of three classes of children of thirteen who were tested both ways two classes showed greater improvement when tested orally, and one when tested in writing. The general results tend to indicate that more lines are reproduced in writing, but that somewhat greater improvement is shown in oral reproduction. This is probably due to the greater disturbance caused by hesitancy in oral than in written language, and to the greater facility of recall which accompanies the improvement in quantity. The difference between the results of

the two methods of testing is however far too slight to account for the wide divergence in the results for different ages.

In considering our general thesis that improvement diminishes with the increasing age of the subject, the reader will observe that there is a gap of about three years between the oldest of the infants dealt with and the youngest of the senior children. If the hypothesis holds good, then children between the ages of eight and eleven ought to show a degree of improvement intermediate between those indicated by the two highest curves in Chart 1.

This was put to the test in a certain boys' school by setting each class to learn "John Gilpin." Ten minutes were allowed, and the second written test was given after an interval of four days. The results are set forth in Table VII.

TABLE VII.

Class	Number in class	Average age	Lines reproduced		Percentage of improvement
			first test	second test	
1	45	12 yrs. 6 mths.	20·2 ¹	22·2	9·9
2	46	12 „ 3 „	8·3	8·4	1·2
3	38	11 „ 9 „	5·4	6·1	12·9
4	47	10 „ 6 „	9·7	10·6	9·3
5	39	10 „ 4 „	9·0	11·7	30
6	52	9 „ 6 „	4·8	7·3	52
7	48	8 „ 7 „	8·4	9·3	10·7

The average percentage of improvement for the children over eleven is 8 and for those under eleven 25·5.

The percentages of improvers for the seven classes in order are as follows: 64·4, 39·1, 55·3, 57·4, 75·7, 79·6, 45·8. The average for the children over eleven is 52·9 and for the children under eleven 64·6.

If these results are compared (*a*) with those of the four days' experiment with "The Wreck of the Hesperus" and (*b*) with those of the four days' experiment in the infant schools, it will be seen that while the results for the boys over eleven approximate to the former, the results for the boys under eleven occupy an intermediate position.

The superiority of the younger children is confirmed by an inspection of the statistics for the earlier experiments. Where the percentage of improvement was highest it was as a rule found that the children were the youngest.

It must be borne in mind that when children of eight and nine are tested under the same conditions as the older children, they are somewhat handicapped by the fact that reading and writing are much

¹ A class of exceptionally bright children.

less automatically performed by them and that visual imagery probably occupies a less prominent part in memorising. It is in fact fairer to test them orally. This was done in a class of girls of about nine years of age, and the percentage of improvement for a two days' interval was 59·6. This clearly supports the hypothesis I am trying to establish.

The evidence in the infant schools is not so clear. In the experiment at schools *A* and *B* the highest degree of improvement was reached by a class of seven-year-olds and the next highest by a class of four-year-olds. In school *C*, however, where the interval was a fortnight, the percentages of improvement for children seven, six and five years old were 22·9, 34·3, and 97·4 respectively, and the percentages of improvers 69·9, 76·6, and 96·7 respectively.

There is accordingly abundant evidence to show that from the ages of five to fourteen there is generally a gradual and uninterrupted decline in the extent to which the power of recall improves with the lapse of time.

The data I have been able to obtain respecting subjects over the age of fourteen are more scanty. Thirty-five subjects (boys and girls) between the ages of fourteen and fifteen improved by 5 per cent. after an interval of two days, thirty-six subjects between the ages of fifteen and sixteen improved by 8 per cent., and ten subjects from seventeen to nineteen years old deteriorated by $1\frac{1}{2}$ per cent.

Through the courtesy of friends I found it possible to obtain from training colleges the papers of students who were tested in the same way as the elementary school children. The results are shown in Table VIII.

TABLE VIII.

Interval	Number of students	Percentage of improvement	Percentage of students who improved
1 day	22	- 9·9	41
2 days	13	- 28	14·3
3 „	35	- 9	31·4
5 „	9	- 30·8	22·2
7 „	80	- 17·8	22·5

The first four groups, which consisted entirely of men, dealt either with an old version of the ballad of "The Bailiff's Daughter of Islington" or with Matthew Arnold's "Saint Brandan"; and the last group, which contained women only, was given Newbolt's "Ballad of John Nicholson." For the two and five days' experiments the number of subjects was so small that the results are of little statistical significance. The general trend of the curve is however unmistakable, and is quite in conformity

with the outcome of other tests which I had previously given to students of this type. As a rule a group of subjects over 20 years of age is incapable of improving upon its initial aggregate record.

From an examination of Charts 3 and 4 it is clearly seen that, generally speaking, as the subject gets older his memory gradually loses the property of improving without being refreshed by further learning.

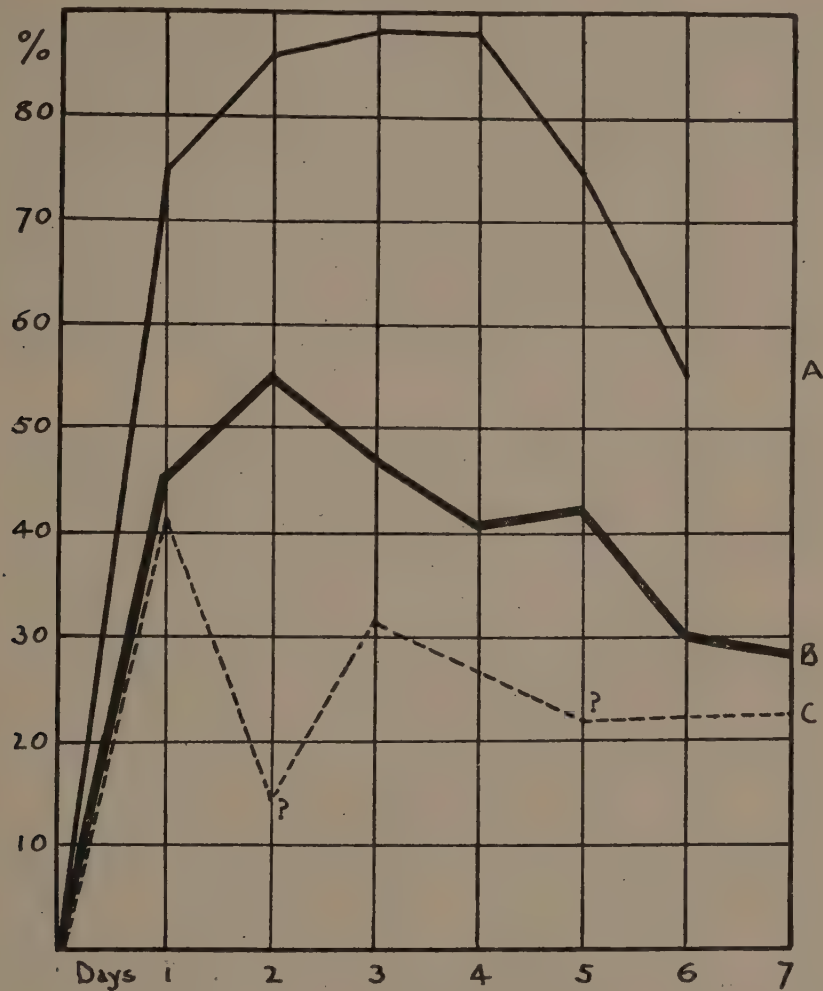


Chart 4. Percentage of subjects of different ages whose memories improved.
A, 6 years old; B, about 12; and C, 21.

*Improvement in the Facility of Recall as distinct from
the amount recalled.*

In conducting these experiments it was observed not only that the children wrote more lines at the secondary test than at the primary, but also that they took less time over the task. In some cases the time taken was recorded on each paper and comparisons were made. It was thus found that, making allowance for the extra number of lines written,

there was for an interval of two days a gain in time of 25 per cent. in the case of one class, and of 13 per cent. in the case of another. In other words the time taken for the secondary tests was only 75 per cent. in one case and 87 per cent. in the other, of the time taken for the primary test. For an interval of five days the time gained in three classes amounted to 10, 38, and 29 per cent. respectively.

I confirmed the general inference by a series of tests of a somewhat different nature. The quantity learnt by the class and reproduced at each test was kept constant. The poem generally used was Longfellow's "The Arrow and the Song." It contains but 12 lines and can easily be memorised by the majority of a class of children about 12 years old in 10 minutes. They were tested immediately, and again after the lapse of a few days. The average gain in speed of recall for two classes after an interval of four days was 21 per cent. For six classes there was on the average a gain of 21 per cent. in five days. A class in another school gained 29 per cent. in a week.

It was impossible to secure uniformity of results owing to variability in the writing habits of children in different schools, and to the difficulty of determining when to end the time given for learning. An endeavour was made to ensure that the children wrote equally well on both occasions; and all those who at either test failed to reproduce the whole piece were excluded from the experiment. I cannot claim that complete success was achieved in eliminating all elements which interfered with the exact measurement of facility of recall. Perhaps the success was greatest in a series of experiments which were made with the same class of boys under conditions which were kept fairly constant. As in all the other experiments each interval involved a separate experiment with a separate poem. The percentages of gain in time for the intervals from one day to five were 15·3, 21·7, 26·5, 37·5, and 21·4, respectively. The three days' experiment was made twice, giving 26 per cent. gain on one occasion and 27 per cent. on the other. This indicates a satisfactory degree of reliability. The percentages of children who took less time at the secondary test than at the primary were for the five intervals 81, 81, 90, 100, and 96, respectively. The curve of facilitation for this class is given in Chart 5. The number of cases taken was so small and the conditions of the test so difficult to keep constant that it is precarious to draw any quantitative conclusions. I do not by any means feel certain as to the more favourable interval for facilitation. The only fact clearly demonstrated is that facilitation, and often a considerable amount of facilitation, takes place without further repetition of the lines.

Although I have not attempted to measure it, the improved facility in the oral tests of infants and mentally defective children was much more marked than in the written tests of the other subjects.

Analysis of the Memory Curve into Elements of Retention and Reminiscence.

Plato used the term Reminiscence in quite a definite sense. It embodied his theory of Knowledge. The acquisition of knowledge was merely the awakening of lost memories—memories of experiences in a prenatal existence. It need scarcely be said that in this monograph I exclude all metaphysical implications. Apart from the Platonic meaning, the term is by no means free from ambiguity. Over and

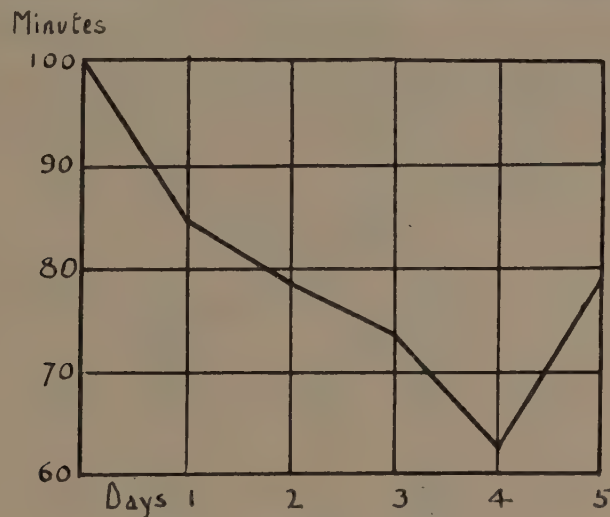


Chart 5. Rapidity of recall.

above the loose popular sense of the term as indicating the mere recollection of things experienced in the more or less remote past, it may bear three distinct meanings.

First and foremost, it may mean the opposite of obliviscence. As obliviscence is a gradual process of deterioration in the capacity to revive past experiences, so is reminiscence a gradual process of improvement in that capacity. Secondly, the term implies the actual act of reviving without further learning an experience which had been forgotten; and thirdly, it may signify the product of such revival. In the main I use the word in the first of these three senses.

It will be observed that I have so far spoken mainly of the improvement in the capacity to reproduce lines of poetry memorised, and have made but little reference to reminiscence proper. It might indeed be thought that since the improvement referred to is due to

reminiscence, as according to my definition of the term it obviously is, the amount of improvement would indicate the amount of reminiscence. But this is not so. Suppose for instance a subject wrote correctly six lines at the primary test and six lines at the secondary test. One would naturally infer that the lines written at the two tests were identical. But a scrutiny of the actual papers reveals the fact that this is frequently not the case. What often happens is that the pupil loses one or more of the original six lines and remembers one or more that were not remembered at the primary test. In other words reminiscence has taken place. So it is when the pupil improves. The amount of reminiscence is frequently greater than the difference between the two measures. And not even when the pupil's record deteriorates does it follow that no reminiscence has taken place. This will be made clear in Table IX which gives a few specimens of the results obtained from a class of boys between 10 and 11 years of age who memorised some lines from "John Gilpin" and were tested the second time four days afterwards.

TABLE IX.

Name	Lines written at first test	Lines written at second test	Fresh lines at second test
F. B.	25	26	2
A. C.	9	10	2
H. S.	8	5	4
V. S.	23	23	2
D. B.	20	16	4
etc.			

There were 46 boys in the class. At the primary test a total of 449 lines was written, and at the secondary test 465, of which 107 were new. Thus the class as a whole had forgotten 91 lines, had retained 358, and had recovered 107. In other words there had been 20·3 per cent. of obliviscence, 79·7 per cent. of retention, 23·8 per cent. of reminiscence, and 3·6 per cent. of improvement. Indeed it always happens with a class of pupils, and nearly always happens with the individual pupil, that after the lapse of a few days there have been both a loss and a gain, and the final amount reproduced represents the balance. It will thus be seen that the amount of improvement by no means measures the amount of reminiscence. The latter is at least as great as the former, and is generally much greater. Among the large number of classes tested, although many have shown a loss at the secondary test, no instance has been found where no reminiscence has

taken place. At the early stages of this investigation it was believed that the difference between improvement and reminiscence was too small to be significant, but as the investigation proceeded it became abundantly evident that the difference was far too great to be ignored. I accordingly decided to have the papers written by the children gone through again with the view of discovering the number of reminiscent lines. But unfortunately most of the papers, which had been kept at the schools, had been destroyed, and it was necessary to conduct a fresh series of experiments. This was not an unmixed disadvantage; for I was obliged to extend the field of experiment, and in some instances to re-test the same children. Means was thus afforded of checking the reliability of the earlier results. This new series was conducted in the same way as the old, but no distinction was made between ballads of the easier type, such as "The Wreck of the Hesperus" or "John Gilpin" and those of a more difficult type, such as "The Ancient Mariner." It would be both tedious and unnecessary to give the results for each class tested. It will suffice to give as a sample the figures for the 19 classes tested with an interval of four days. (See Table X.)

TABLE X. *Ballad Poetry. Four Days' Interval.*

Sex	No. in class	Av. age yrs. mths.	Av. lines at first test	Av. remi- niscent lines	Percentage of			
					improve- ment	retention	remi- niscence	remi- niscents
Girls	35	12 0	15.5	6.8	36.1	92.4	43.7	100
Boys	42	12 5	15.5	5.2	26.5	93.0	33.5	95.2
„	37	10 4	9.0	3.0	31.8	98.8	33.0	81.1
Girls	37	12 9	22.9	7.0	24.8	94.4	30.4	96.6
„	43	11 8	14.3	3.6	— .8	74.0	25.1	93.0
Boys	46	10 6	9.8	2.3	3.6	79.7	23.8	73.9
„	45	12 3	8.3	1.9	3.2	80.8	22.4	66.7
„	54	11 4	7.9	1.7	— 6.8	71.2	21.9	83.0
Girls	38	12 2	23.5	4.6	11.3	91.5	19.8	84.2
„	38	11 3	16.0	3.0	— 7.1	74.3	18.5	89.5
„	32	12 9	24.0	4.3	12.1	94.2	17.9	97.0
„	37	11 6	12.3	1.9	1.3	85.7	15.6	73.0
Boys	35	13 6	14.5	2.1	— 17.9	67.7	14.4	80.0
„	40	11 6	11.5	1.5	— 11.8	74.7	13.5	69.4
„	34	12 8	6.1	.8	— 36.3	50.2	13.4	47.1
Girls	41	12 4	24.4	3.2	— 3.5	83.3	13.2	92.7
Boys	37	10 10	5.2	.5	— 5.2	84.4	10.4	43.2
Girls	47	13 2	24.8	2.6	.2	89.9	10.3	87.2
Boys	40	11 6	10.6	.9	— 15.0	76.5	8.5	55.0

The summarised results for the whole series of tests are given in Table XI.

TABLE XI. *Ballad Poetry. Summarised Results.*

A	B	C	D	E	F	G	H	I	J
1	22	859	12 3	14.9	3	11.9	91.4	20.5	80.9
2	23	875	12 3	13.9	3.2	14.4	91.2	23.2	77.4
3	13	374	12 3	13.9	2.8	9.2	89.3	19.9	78.0
4	19	751	12 0	14.4	3	4.8	84.3	20.5	79.4
5	10	423	12 2	14.6	3.1	.4	79.3	21.1	87.6
6	8	319	12 3	12.0	2.3	-6.4	74.9	18.7	78.2
7	5	179	12 5	18.1	2.8	1.1	85.9	15.2	70.8

A. Days' interval.

B. Number of classes.

C. Number of children.

D. Average age.

E. Primary test, average number of lines.

F. Average number of reminiscent lines.

G. Improvement, per cent.

H. Retention, „

I. Reminiscence, „

J. Reminiscent, „

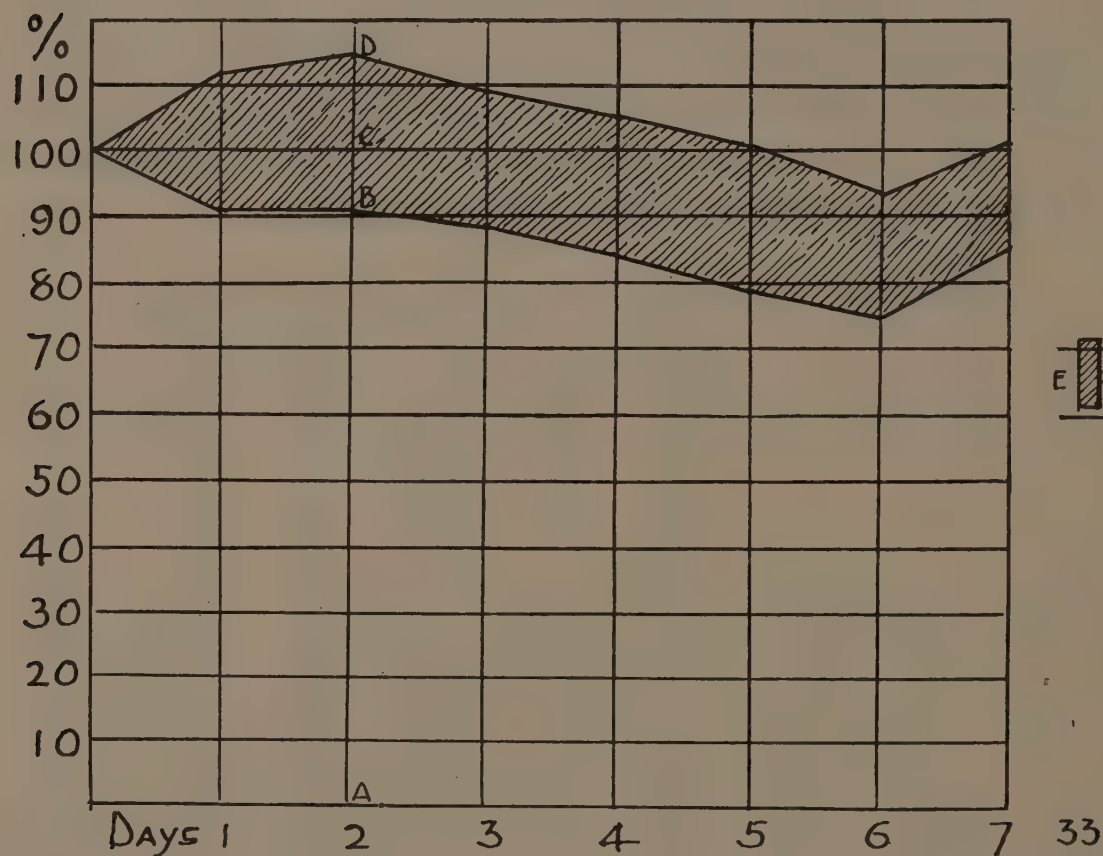


Chart 6. Reminiscence. Ballad poetry learnt by children about 12 years of age. The upper curve shows the amount recalled after the various intervals, and the lower curve the proportion of it that had been remembered immediately after memorising. The shaded area represents Reminiscence. For example, 100 per cent. being the number of lines initially reproduced, *AB* represents what was retained of them after two days, and *AD* the total number of lines remembered. Thus *AB*=Retention; *CD*=Improvement; *CB*=Obliviscence; *BD*=Reminiscence. *E* indicates the amount of Reminiscence manifested 33 days after learning. No special significance is to be attached to the rise on the seventh day, for the number of subjects for this interval was comparatively small (see Table XI).

The averages and percentages were calculated not by taking the mean of the averages and percentages of the individual classes, for all the classes were not of the same size, but by using the total number of lines correctly written at each of the two tests. The significance of these results can be more readily understood by the study of Chart 6. Taking the ordinate which represents the amount memorised in the experiments for the two days' interval, it will be seen that *AC* marks the amount initially learnt, *AB* the amount retained, *CD* the amount of improvement, *BD* the amount of reminiscence, and *BC* the amount of obliviscence. The number of cases taken for the longer periods is too small to give normal curves; but up to five days fairly reliable averages are indicated. It will be observed too that the upper curve confirms the results of my earlier experiments. Most of the tests have been massed within the first four intervals, for it was thought probable that there, if anywhere, the secret of reminiscence was to be found. With children of about twelve years of age reminiscence takes as a rule two days to develop, although the bulk of it takes place during the first day. After the second day the memory curve has a steady downward tendency, and runs almost parallel to the retention curve; but not quite parallel, for the reminiscence area narrows just as the retention area narrows with time. It is pertinent to enquire whether the two areas narrow at the same rate. After the second day does the amount of reminiscence bear a constant ratio to the amount of retention? The former calculated as a percentage of the latter becomes for the seven intervals: 22·4, 25·4, 22·3, 24·3, 26·6, 25, 17·7. Seven experiments were carried out with 33 days intervening between the primary and secondary tests, and the issue throws some light on this matter. The summarised results show that after nearly five weeks 61·1 per cent. is retained and 10·3 per cent. recovered. This gives 16·8 to 100 as the ratio of reminiscence to retention. The evidence indicates that obliviscence is a little more active among the reminiscient elements than among the retained elements. This conclusion accords with what we know of the nature of the reminiscient elements. Whatever theory one may hold with regard to the cause of reminiscence, it is certain that the mind has a looser grip of reminiscient material than of material that is always readily reproducible. It constitutes the less stable part of one's mnemonic equipment. Indeed common experience teaches us that those things which we sometimes forget and sometimes remember are especially liable to pass completely beyond the reach of recall. In the chapter dealing with the question of fatigue ample evidence is adduced to show

that long after the second day reminiscence accompanies obliviscence, and the reminiscent material being constantly recruited, obliviscence must be singularly active among that material to keep the supply as low as it actually is.

It is now necessary to reconsider our conclusions with regard to the influence of age and of the material memorised upon the memory curve. First let us take the material memorised. It has been seen (page 20) that for ballad poetry the percentage of reminiscence for the first five days is about 20. The data for nonsense verses were much more meagre; but from the figures in hand the percentages of reminiscence during the first seven days are 11, 32, 36, 4, 7, 15, 2. These figures indicate a high degree of reminiscence during the second and third days, followed by a rapid decline.

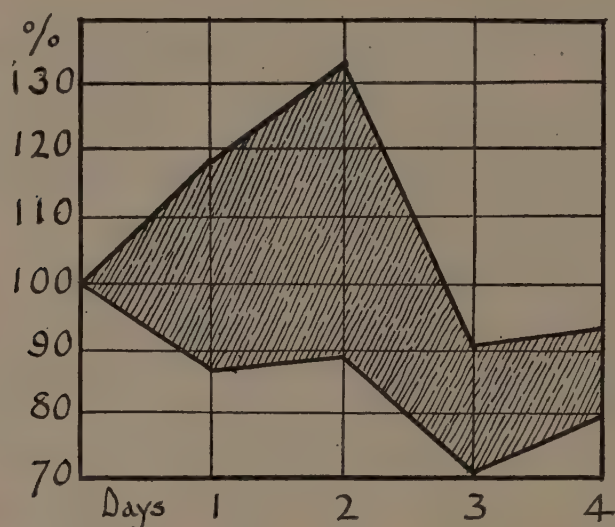


Chart 7. Reminiscence. Class of girls about 11 years old. "The Ancient Mariner."

Five classes were selected in different schools for the purpose of carrying on a continuous series of experiments on the same children with intervals of from one to four days between each pair of tests.

The first was a class of 27 girls of average age $11\frac{1}{3}$ years. They learnt different parts of the same poem—"The Ancient Mariner," and the result is shown in Chart 7.

A class of 38 boys whose average age was twelve years and eight months learnt in the same way different portions of "John Gilpin." The outcome is seen in Chart 8. Continuous pieces of this kind present some difficulties. Although there is unity of theme and metre the different stanzas and sections are by no means equally memorable. There is moreover the absence of novelty in the later tests, together

with a liability on the part of the children to confuse later with earlier stanzas.

Similar difficulties however appear when fresh poems are selected for each interval. This mode was adopted in experimenting with a class of 40 young boys not quite eleven years of age. (See Chart 9.) The four poems selected were: "Excelsior," "Three Fishers," "The Peel Life Boat" (by T. E. Brown) and "The Canadian Boat Song." The

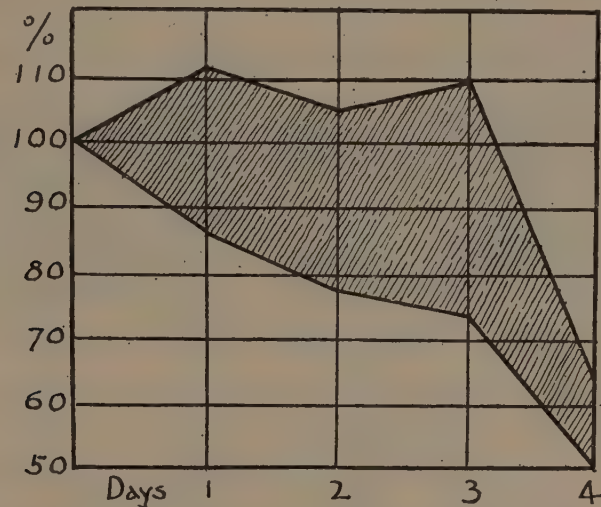


Chart 8. Reminiscence. Class of boys about 13 years old. "John Gilpin."

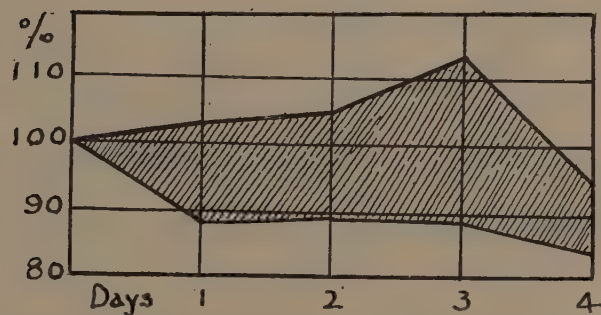


Chart 9. Reminiscence. Class of boys about 11 years old. Selected poems.

maximum reminiscence, which appears at the fourth day, seems to be due to the nature of the poem, for the same poem has given rise to abnormal reminiscence among a totally different class of boys.

A series of similar experiments comprising seven different intervals was made with a mixed class of 43 children of average age thirteen years and nine months. The results are shown in Chart 10. The poems used for the separate experiments are indicated in the chart. It will be seen that Tennyson's "Brook" proved exceptionally retainable.

The other two classes dealt with a totally different kind of material. They had to reproduce stories read to them out of Laura Richard's "The House with the Golden Windows." Except that the story was read to them three times, and that in marking ideas were counted instead of lines, the mode of procedure was the same as for poetry experiments. The four tales selected were (1) The Giftie, (2) The Open Door, (3) The Hill, and (4) The Walled Garden.

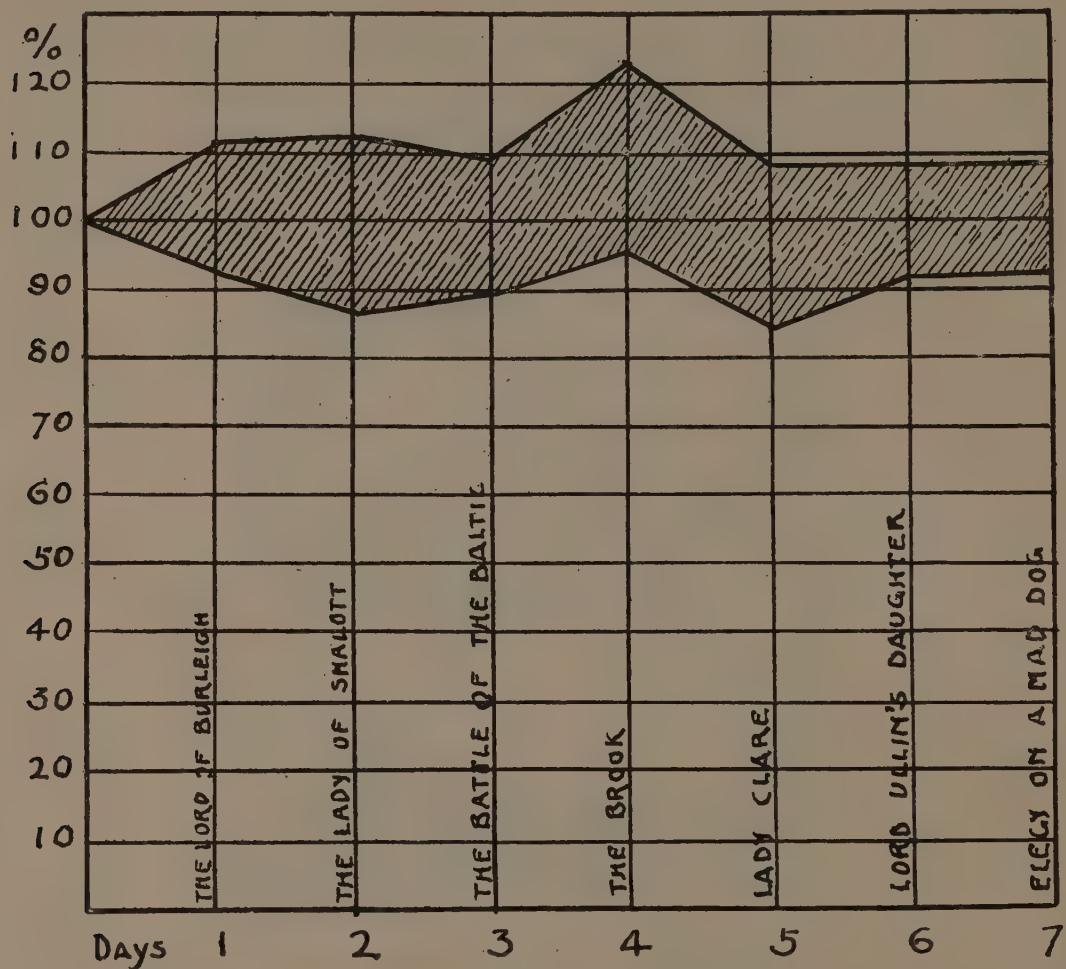


Chart 10. Reminiscence. Class of boys and girls nearly 14 years old.

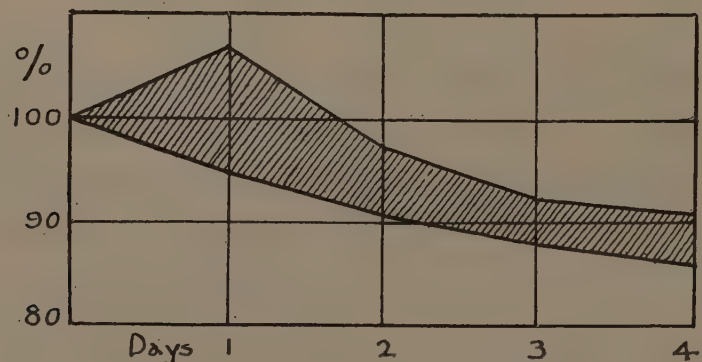


Chart 11. Reminiscence. Class of girls about 13 years old. Stories.

The class whose record is set forth in Chart 11 consisted of 42 girls of average age thirteen years and two months; they took the tales in the order given above. The other class which consisted of 17 girls of average age thirteen years and five months took the stories in the order 1, 3, 4, 2, and their record is seen in Chart 12. A noticeable feature is the low degree of reminiscence when ideas are dealt with as compared with that of rote memory. It should be observed however that the ages of these girls are high.

An experiment was made with a class of 40 girls of thirteen years of age in memorising a prose passage from "A Tale of Two Cities." The piece was for purposes of marking divided into 21 phrases of about six words each, and each phrase was treated as a line of poetry had been treated in the previous experiments. After two days' interval the total marks for the class declined from 540 to 487. Only eight girls improved, but twenty-eight showed reminiscence. The total degree of reminiscence was 10·6; that is, about half as much as for poetry.

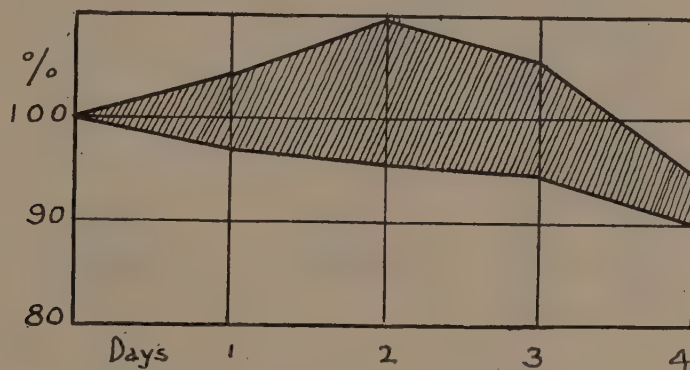


Chart 12. Reminiscence. Class of girls about 13½ years old. Stories.

Two classes were tested with 32 nonsense syllables of the Ebbinghaus type; such as Dar, fep, luf, gop, fim.

One of the classes consisted of 53 boys of an average age of twelve years and three months. After two days' interval the class fared 25·1 per cent. worse than at the primary test. The percentage of retention was 61·3 and of reminiscence 13·6. Only six of the 53 boys improved on their primary score, but 38 of them recovered one or more syllables.

The other class was smaller and older, consisting of 29 boys close upon thirteen years of age. These deteriorated 3·8 per cent. only. They retained 74·9 per cent. and recovered 21·3 per cent. The number of syllables learnt was 13·4 as against 11·4 in the other class.

It will thus be seen that boys find it more difficult to learn one senseless syllable than to learn a line of ballad poetry, that they retain

these syllables less easily, and that they show a somewhat lower degree of reminiscence.

The effect of reminiscence in respect of visual material was tested in two classes. I placed certain diagrams on the blackboard and gave the children ten minutes to learn them (see Fig. 1).

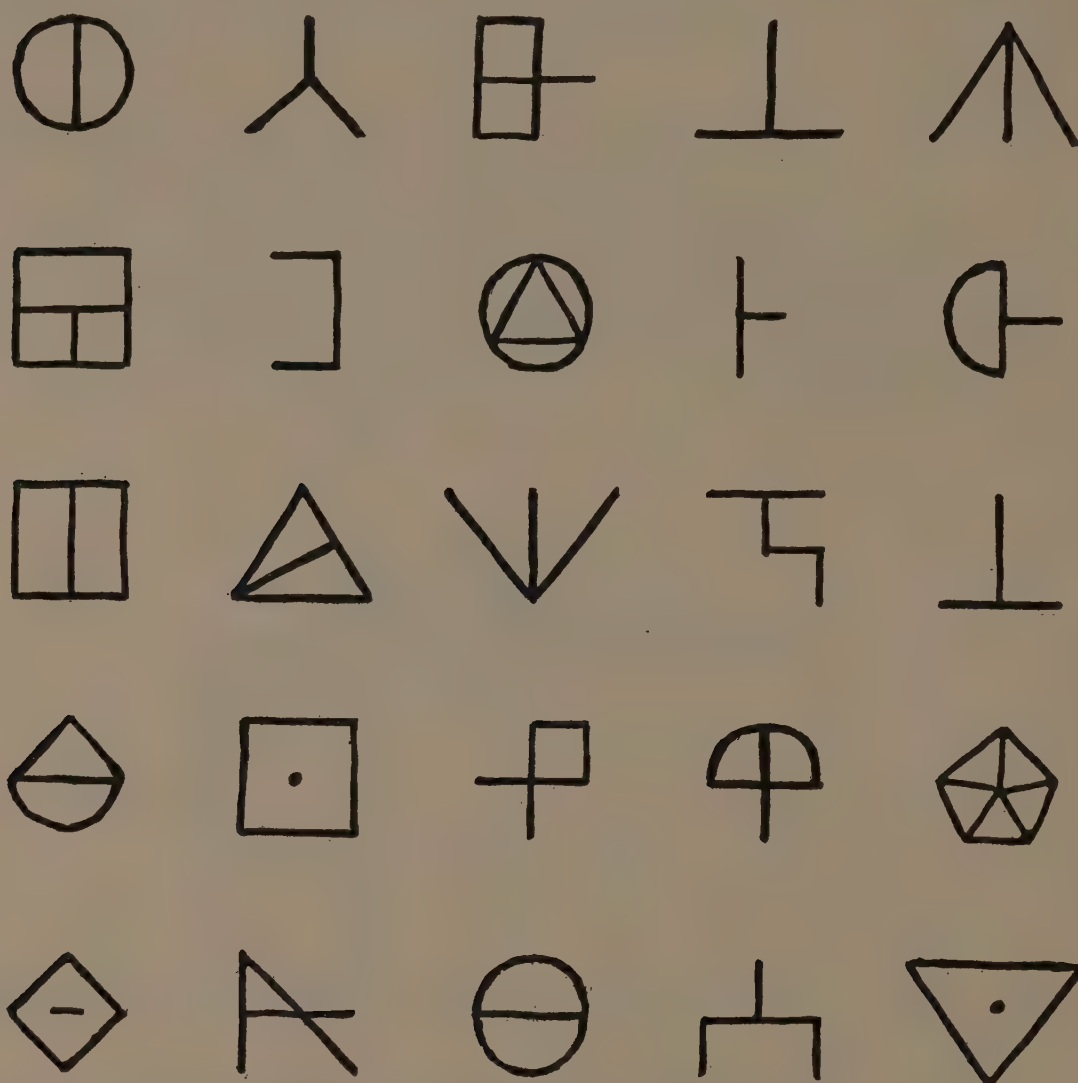


Fig. 1. Diagrams used for visual test.

The results are as follow : The first class, consisting of 45 boys close upon twelve years of age, was able immediately after learning to reproduce an average of 13·5 figures. When tested again after two days, they were found to have retained 80·4 per cent. and to have recovered 21·8 per cent. The other class, consisting of 40 girls, did not do so well. Initially they learnt 12·1 figures, and after two days showed 75 per cent. retention and 16 per cent. reminiscence.

I have also tried to discover the amount of reminiscence that follows the attempt to learn a tune ; but although a marked degree of

improvement unquestionably takes place after two or three days I have not been able to measure it satisfactorily.

Another kind of material, used in an experiment in which twenty classes were involved, consisted of Latin nouns with their English equivalents. This experiment will be described in detail later. Suffice

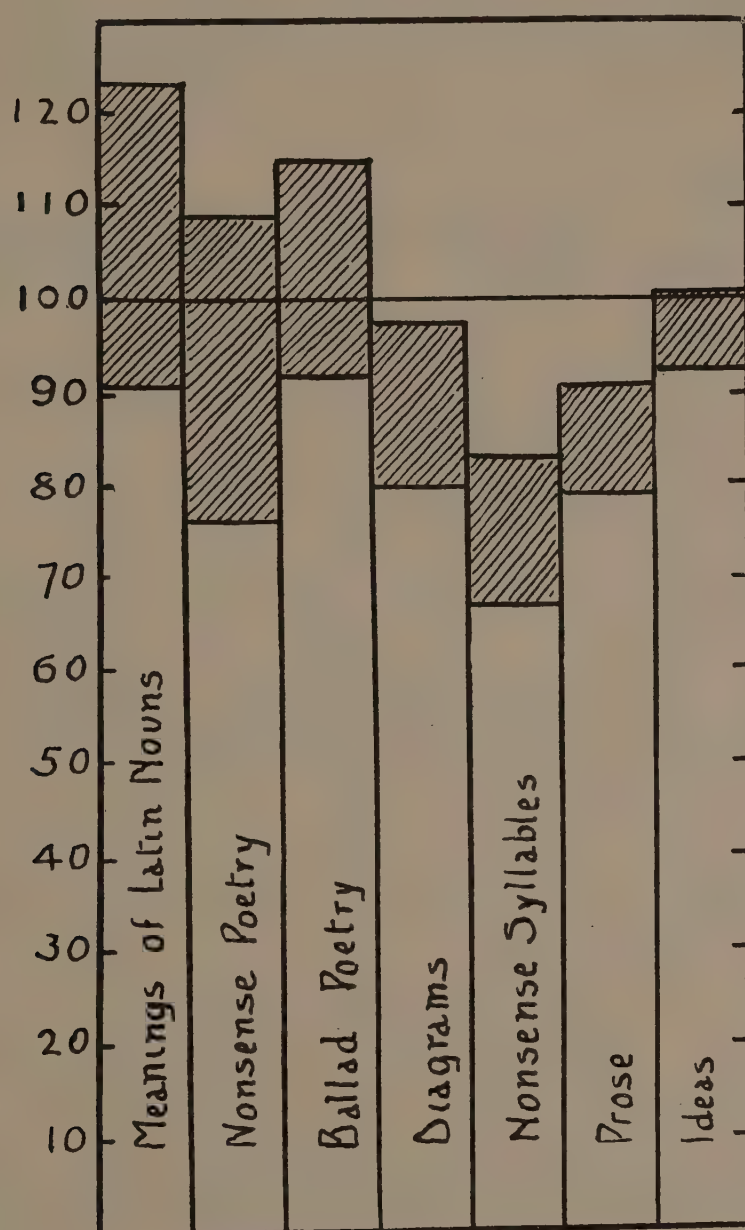


Fig. 2. The degree of Reminiscence manifested in memorising different kinds of material.

it to say now that after a day's interval improvement took place in each of the twenty classes, and that on the average 90·5 per cent. was retained and 32·6 per cent. recovered. A comparison between the effects of varying the material used may be made by looking at Figure 2.

The only columns based on experiment with a large number of children are the first and the third. The others can merely be regarded as indicating the kind of result that has been obtained by the haphazard choice of two or three classes only, and are not presented as possessing much statistical value.

One thing at least is established by these data: no kind of material upon which memory exercises itself is exempt from the operation of reminiscence. Whatever may be remembered may also be forgotten, and whatever may be forgotten may, under certain circumstances, be remembered again.

We have now to consider the effect of age upon reminiscence. We have found that young children's memories improve enormously after a lapse of two or three days, that the memories of children of twelve improve less, and that the memories of adults do not appear to improve at all. But we have shown that reminiscence can accompany an actual decrease in the amount of material reproduced. To measure the amount of reminiscence displayed by infants is not easy, as the lines are repeated orally instead of being written. It has however been done with two classes. One consisted of 23 bright children at the top of an infant school, that is about seven years of age. A careful record was made not only of the number of lines repeated at the two tests but of the identity of the lines. It was found that after attempting to memorise twelve lines in twenty minutes the class was able to repeat a total of 176 lines, or about 7·6 lines per child. After three days' interval the number of lines repeated was 227 of which 63 were reminiscient. It will be seen from these figures that 6·8 per cent. of the lines were forgotten and 35·8 recovered.

The other was a much larger class containing 53 children a year younger, that is, between the ages of six and seven. Initially they learnt on the average five lines each, and after an interval of two days had retained 91·2 per cent. and recovered 48·6 per cent.

It will thus be seen that infants forget quite as much as older children, but they have a relatively much higher capacity for reminiscence.

Through the courtesy of friends experiments of a similar kind to those conducted in Elementary schools have been carried out in two Secondary schools, one for boys and the other for girls. Although I was not able to supervise these tests they were given in accordance with definite instructions, and the results are set forth in Table XII. They are arranged in accordance with the ages and not the classes.

TABLE XII. *Interval, two days.*

Age	Number of pupils	Lines learnt	Percentage of			Lines re-covered
			retention	reminiscence	reminiscents	
14-15	35	20.7	91	14	74	2.9
15-16	36	21.3	92.3	15.7	86	3.3
17-19	10	20.9	81.3	17.2	100	3.6

Compare with these the results obtained with Training College students as set forth in Table XIII, and plotted in Charts 13 and 14.

TABLE XIII.

Interval in days	Number of students	Lines learnt	Percentage of			Lines re-covered
			retention	reminiscence	reminiscents	
1	22	12.9	79.5	10.6	77.3	1.4
2	13	14.3	67	5	46.1	.8
3	35	17	75.7	15.3	80	2.6
5	9	18.8	65.7	3.5	44.4	.7
7	80	23.9	71.3	10.9	83.7	2.6

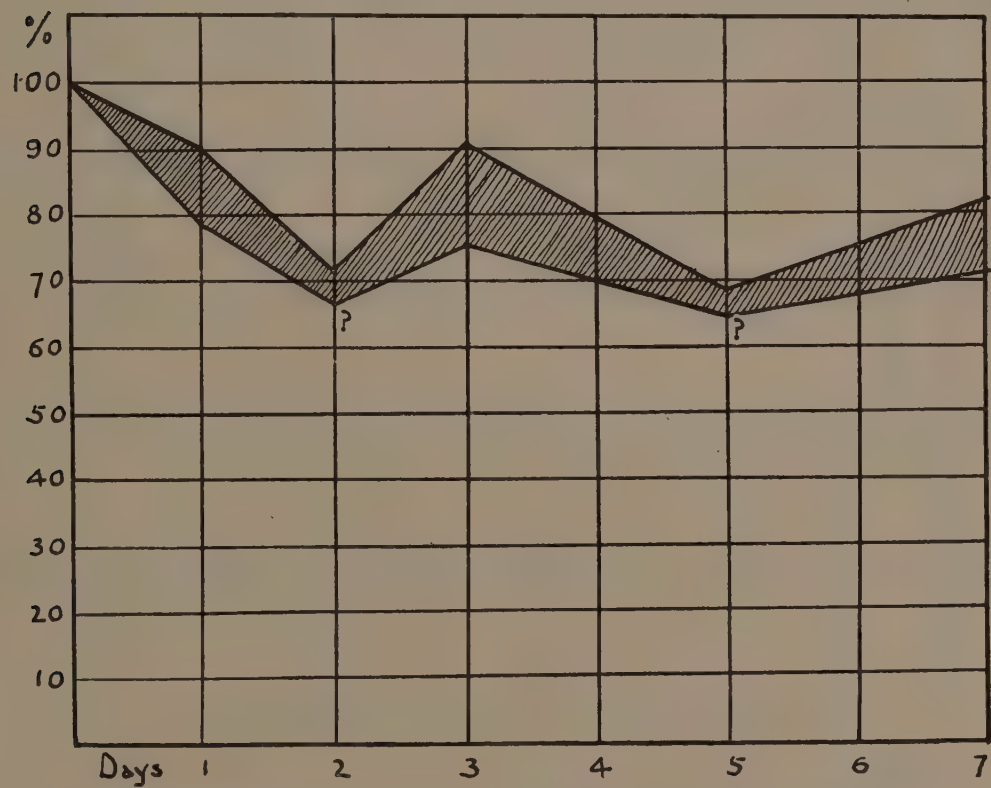


Chart 13. Reminiscence. Training College students who memorised ballad poetry.

The somewhat unsatisfactory nature of these latter figures has already been commented on (see p. 14). If the results may be taken as fairly representing the mnemonic powers of subjects over 20 years of age, there is clear indication that women learn more rapidly and are

more retentive than men, and that there exists for subjects of this age a positive correlation between retentiveness and reminiscence.

It will be observed that up to the present we have adopted a somewhat arbitrary means of measuring reminiscence. We have taken

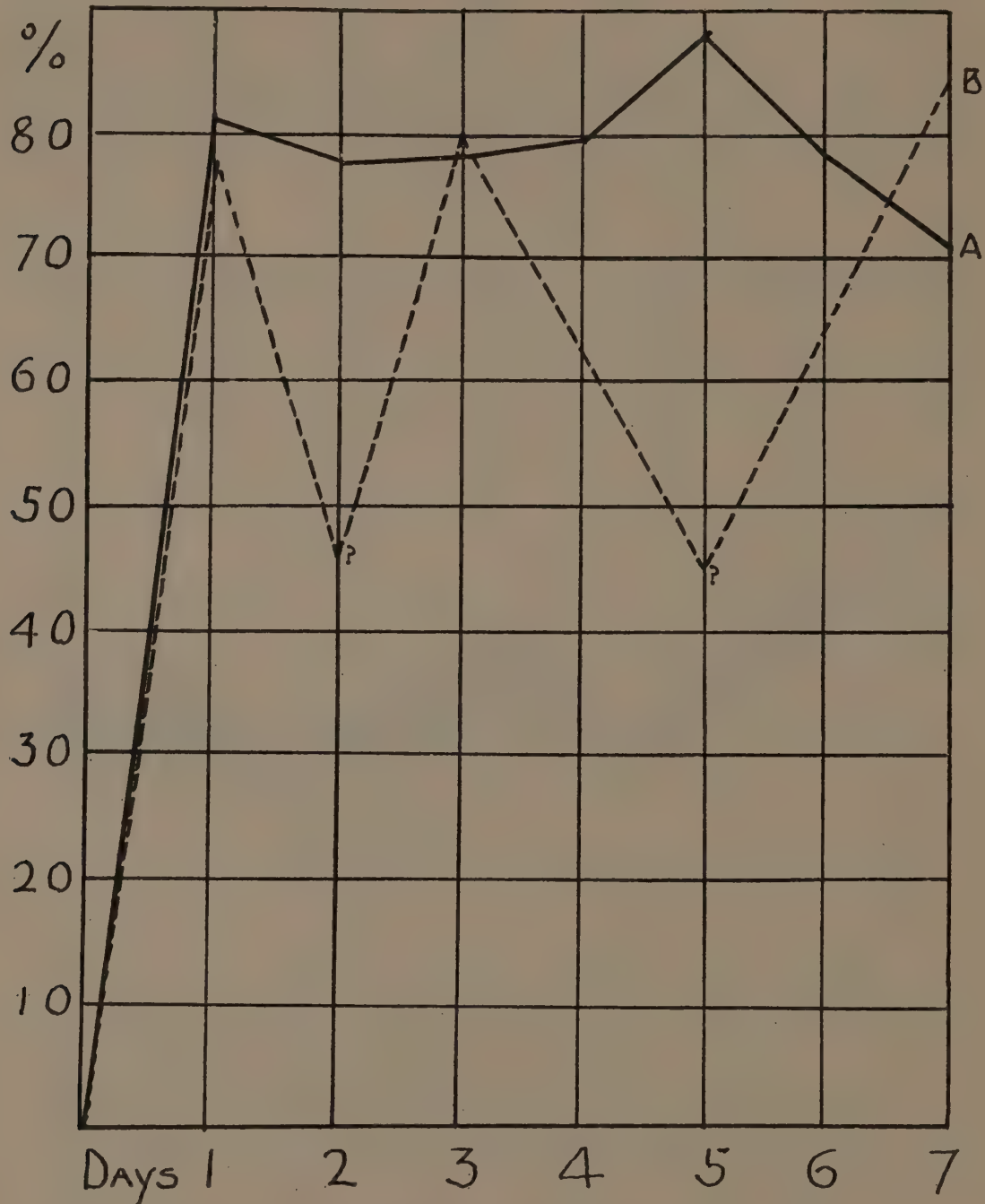


Chart 14. Percentage of subjects who showed reminiscence.
A, 12 years old; B, 21 years old.

the ratio between the number of lines recovered and the number of lines originally learnt. If, for instance, a child of six immediately after learning repeats four lines, and three days after recovers one line, the percentage of reminiscence is estimated as 25. If again a lad of

sixteen learns 20 lines and recovers five, his percentage of reminiscence is also 25. But, regarded absolutely, the reminiscence in the latter case is five times as great as in the former. What we have really been assessing is not so much the power of mnemonic recovery, as the relative importance of that factor in the whole mnemonic life of the subject. When we estimate it independently we get quite different values. Roughly speaking, within the first four days, after a sitting of 15 minutes' memorising, a child of six recovers two lines. At the ages of 12, 14, 16, and 20, the numbers of reminiscent lines are about 3, 3, $2\frac{1}{2}$, and 2, respectively. After 20 there seems to be a rapid decline in the number of lines that can be rendered reminiscent.

Summing up the results of the influence of age on the various aspects of memory, we are justified in drawing the following general conclusions. Up to the age of fifteen or sixteen there is a steady improvement in the rate at which poetry can be learnt, but after that period there does not seem to be much change. The improvement in this respect is very marked at the approach of puberty. If the degree of reminiscence is calculated relatively, by taking the ratio which the number of recovered lines bears to the number of lines initially learnt, then it may be said to hold true generally that reminiscence consistently diminishes with increasing age. When however reminiscence is calculated absolutely by taking the actual number of lines recovered without reference to the number originally remembered, we find that the power of reminiscence improves up to the age of fifteen or sixteen and afterwards gradually declines.

We are incidentally furnished with certain norms which may prove valuable in estimating the powers of memory of a child of given age. If we use ballad poetry, and insist upon verbal perfection, we find that as a rule a child at six, twelve, and fifteen, can at a quarter of an hour's sitting learn 4, 14, and 20 lines respectively. After two or three days the 4 will improve to 6, the 14 to 17, and the 20 to 22 or 23.

Interval for Maximal Reminiscence.

In the case of very young children the interval which secures maximal reminiscence seems to be three days. For older children it is undoubtedly two days. Individuals differ considerably, but as a general rule two days afford the most favourable opportunity. Where in class experiments other intervals seem more favourable than two days, it is generally found that the piece memorised is of special attractiveness to the pupils. To eliminate this factor I tested two classes of

boys, *A* and *B*, with two poems, *C* and *D*. *A* was tested with *C* for a two days' interval and with *D* for a three days' interval; while *B* was tested with *D* for a two days' interval and with *C* for a three days' interval. *C* proved the more interesting and memorable poem and provoked the greatest reminiscence each time, but the balance of advantage was clearly in favour of the two days' interval.

It will be remembered that in dealing with the increased facility of reproduction with the lapse of time we found the improvement continued up to the end of four days. This facilitation is probably of the same nature as the ordinary facilitation which accompanies the development of a motor habit. It has been found by other experimenters that the most favourable pause for developing the results of practice in acts of physical skill is considerably over two days. The better results obtained for the three days' than for the two days' interval in the experiments with nonsense verses is possibly due to the alliteration and rhythm of the verse, which appeal largely to our motor sensibilities.

A significant fact comes to light in Chart 2, which gives the percentage of subjects who improve. It will be seen that in each of the three curves there is a second rise about the fifth day. When we come to consider, not the number of subjects who show improvement, but the number who give evidence of reminiscence, we find a similar phenomenon. In the series of reminiscence tests with ballad poetry it will be seen from Table XI that the highest percentage is on the fifth day. A glance at Chart 14 will reveal the double apex, one at the end of two days and the other at the end of five. The reappearance of this second crest in four independent series of tests points to something which is probably more than coincidence. It is not unlikely that there are two fairly distinct psychophysical factors concerned in the phenomena of reminiscence. Without raising the controversial question of the existence of a purely psychical memory as distinct from physiological memory, I may safely distinguish between those cerebral processes which underlie the higher mental functions, and those which subserve overt acts. It is conceded that motor elements are concerned in both, but while in the former case the conscious aim and purpose of the subject is thinking, and whatever motor processes are involved are subordinate and sub-conscious, in the latter case the aim and purpose is doing, and the motor result is the very essence of the whole operation. The thought involved is a means to the achievement of the motor result. If I may call the two types of processes the intellectual and the motor, it may be stated generally that where the intellectual element predominates the

interval for maximal reminiscence tends to be shortened, and where the motor element predominates the interval tends to be prolonged. Colour is lent to this view by the rapidity with which the reminiscence of ideas falls off, indicated by the results of the tests in reproducing stories (see Charts 11 and 12).

Simple and Compound Reminiscence.

If we are to believe the introspective evidence of the subjects, in the majority of instances the poem is not thought of at all in the interval between the two tests. Some children however confess to have pondered over it and to have tried to repeat it to themselves. In the first case the attempt to recollect, which serves as a stimulus to reminiscence, took place once only, and the reminiscence may be said to be simple; in the second case there was a repetition or series of repetitions of the attempt, and the reminiscence may be described as compound. Of 40 children who were questioned individually in Class I of Infant school A, ten acknowledged having thought of the poetry at home or to have repeated it to their mothers. The other thirty denied having thought about it at all. The percentages of improvement for each of the six intervals are here compared with the percentage for the whole class.

	Percentages of improvement for intervals of					
	1 day	2 days	3 days	4 days	5 days	6 days
The 10 in question	23·5	56·8	61·2	60	64·3	63·1
The whole class	28·9	54	66·7	68·3	93·1	74·1

The evidence however of children so young as these is notably untrustworthy. More importance may be attached to the statements of the senior children in the elementary schools. In the following statements the subjects who confess that they went over the poem in their minds between the two tests are called *A*'s, and those who deny having thought of it are called *B*'s. In a class of 34 girls the 14 *A*'s showed 92 per cent. retention and 25·6 per cent. reminiscence, as against 81 per cent. and 25·5 per cent. respectively on the part of the 20 *B*'s. In another class of the same school where 26 were *A*'s and 8 were *B*'s, the latter were a trifle better than the former with 21 per cent. reminiscence as against 20·6, and 93·4 retention as against 93. In the next class the *A*'s showed about 1 per cent. more reminiscence than the *B*'s. In a class of 35 boys the 17 *A*'s showed twice as much reminiscence as the 18 *B*'s, and in another class of 42 boys the 9 *A*'s showed 35 per cent. reminiscence and the 33 *B*'s 22 per cent. Instances may be multiplied

showing superior reminiscence as a rule on the part of the *A*'s, but occasionally on the part of the *B*'s. The probability is that the claim to have pondered over the poem does not amount to much. It may merely mean that a few stray lines had spontaneously returned to their minds.

More reliable perhaps is the result of an experiment with a class of girls between 11 and 12 years of age. They have good memories and take much interest in their school-work. The percentage of reminiscence they had displayed in previous tests was about normal. I tested them for this special purpose with Will Carleton's "Uncle Sammy." They had never seen it before, and there was no copy of the poem in the school or in their homes. They were given 15 minutes to learn it, and at the end of the time wrote out an average of 20.9 lines each. They were then told that in three days' time they would be again tested and they were asked to try to recall in the meanwhile as many lines as they could, but they were put on their honour not to talk to each other about it or to attempt to get hold of the poem. In order to stimulate effort a prize was offered to the girl who could reproduce the largest number of lines. At the secondary test the average number of lines written was 22.3. They showed 82.8 per cent. retention and 23.9 per cent. reminiscence. This was in no way remarkable. In fact they had previously done quite as well when they did not expect the secondary test. The unique feature however was that every one of the 38 girls recovered one or more lines. Except in Infant schools it rarely happens that 100 per cent. of the subjects show reminiscence. It seems to mean that every child can recover memories if he tries his best. If these data were reliable they would point to the conclusion that reminiscence is influenced, though to no very great extent, by repeated efforts to recall. It is difficult however to know how much importance to attach to the assertion of the children that they have thought of the poetry at home. Does it mean anything more than the casual passing through their heads of a few haunting lines or a few haunting stanzas, which they would possibly have remembered in any case? Are they, in other words, cases of fragmentary perseveration? It will be seen later that there is abundant evidence to show that when a *systematic* effort is made to recall the test-piece it always has a marked influence upon the reminiscence that follows.

Reminiscence conditioned by the Age of the Associations.

A certain class of 46 boys, whom I tested with a poem called "A Cripple Boy," when asked to write it out on the following day improved upon their primary record by 40 per cent. With one day's interval they manifested 58·7 per cent. reminiscence. This was in itself surprising; but it was more surprising still when they were further tested with another poem and after a two days' interval recovered only 15 per cent. of the lines. On investigation it was found that the first poem was contained in the reading books used by the class the previous year, and although the boys had not learnt the poem by heart, yet they were quite familiar with it. This discovery suggested the query: What happens when an attempt is made to revive lines learnt years before and now entirely forgotten? In a class which had previously been tested and had proved to be normal in respect to reminiscence, 16 boys were found who had learnt "The Burial of Sir John Moore" four years before, and had not seen or attempted to revise it since. They seemed to have forgotten it entirely. I read the poem to them once only and asked them to write out all they could remember. They wrote out 155 lines altogether, that is, nearly ten lines each. This was towards the close of an afternoon session. Early next morning the boys were asked to write out all they could then remember. The total was 226, of which 75 were fresh lines. All but one wrote out more than he did the previous afternoon, and even the one exception wrote one reminiscent line. It will be seen that they had in about 18 hours improved by 45·8 per cent., had retained 97·4 per cent. and had shown 48·4 per cent. reminiscence. They were tested again without further learning on the third day following the secondary test. They now wrote 240 lines, of which 38 had not previously appeared. That is, an additional 16·8 per cent. of reminiscence had taken place during the second interval. In fact during three and a half days 72·9 per cent. of reminiscence had taken place.

More remarkable still is the case of 19 boys of about thirteen years of age who about four years previously had learnt Kingsley's "Three Fishers." I read it to them once on a Monday afternoon. They were tested immediately after, again on Tuesday morning, and yet again on Wednesday morning. The total number of lines reproduced on the three occasions were 159, 238, and 362. On the Tuesday 110 lines were recovered, and on the Wednesday 124 additional lines. Thus in less than two days 147 per cent. of reminiscence had taken place. So far as I could discover, no boy had in the meanwhile seen a copy of the

poem. They were very poor boys and it was not at all likely that they possessed copies at home.

These results have been confirmed by similar tests in other schools.

All this goes to show that reminiscence is most active among old memory material. And indeed it mainly manifests itself in this form in the mental life of the adult. When a man writes his reminiscences (in the loose sense of the term), he is aided by a large measure of reminiscence, in the limited sense in which the term is used here. If the reader will concentrate his mind on any short and well-defined period in his past life and try to recall and to record the events of that period, and after he has exhausted his recollections will dismiss the matter from his mind and attack the topic again the next day, he will probably find that a number of other events will readily be recalled. The effort to recollect past experiences sets up some sort of disturbance among submerged associated memories, a disturbance which continues when the conscious mind is otherwise engaged, and which in a short time brings some of them up to the surface. And when they come, they tend, after a further delay, to bring up more of their associates.

Perhaps the simplest and most common type of reminiscence is that involved in the recovery of a lost name. I meet a person with whom I was acquainted years ago, but I cannot remember his name. It is 'on the tip of my tongue,' and yet, try as I will, I cannot quite recall it. I give up the attempt at last and turn my mind to other things. In a short time the word comes into my mind of its own accord, often when I am thinking about something else. Hence to recall part of a system of associated ideas is to generate reminiscent activity in the unremembered part of that system.

In all the experiments I have so far described there have been two tests, the primary and the secondary. Neither of the tests can be dispensed with if reminiscence is to be measured or even detected. Yet we cannot avoid asking the question: What would have been the effect of the omission of the primary test? If the subjects had not been required to write out what they remembered immediately after learning, would the same amount of reminiscence have taken place, or was the effort made to reproduce the poem an essential factor in determining reminiscence? An attempt to assess the importance of the primary test was made in this way. I adopted the equal group system with which Mr Winch has made us familiar¹. A class of girls was tested twice in their powers of memory and reminiscence and was divided into

¹ *J. of Educ. Psychol.* x. 16—17; 561, etc.

equal divisions *A* and *B*, so that their records balanced. The whole class was given 15 minutes to learn 32 lines from "John Gilpin," beginning, "The dogs did bark, the children screamed." Division *A* alone was given the primary test. Two days after, both divisions were asked to write out what they could remember. Division *A* wrote in the aggregate 140 lines, while division *B* wrote 118. The number written by division *A* at the primary test was 114. It would thus appear that, if the divisions were really of equal ability, the primary test was an important factor in causing the reminiscence. But the class was again tested with the divisions reversed. The test piece this time was also from "John Gilpin." The passage began, "At Edmonton his loving wife." It was division *B* that was given the primary test this time. At the end of two days division *B* which had previously written 149 lines, now wrote 174, while division *A*, which had not been previously tested, wrote 194. In fact, although the experiment was carried out with extreme care we seemed to get contradictory results. It may be remarked that the number of girls in each division was not large; for if any girl was absent from any of the four tests both she and the girl 'tied' with her had to be excluded from the experiment. Thus only 13 girls were left in each division. Then again, it was evident that we had not succeeded in getting divisions of equal ability. Division *A* was manifestly superior. Moreover the second passage was found to be more easily memorised than the first. When however we carefully compare the two results we find that the balance of advantage is on the side of the double test rather than the single test. For we see that, when it had the advantage of a primary test, division *A* beat division *B* by 18·6 per cent.; but when there was no primary test it beat it by only 11·5 per cent. The conclusion to which we come is that the act of writing out the lines immediately after memorising has an effect, but only a slight one, upon the subsequent reminiscence. Not indeed that active recall is absent when no immediate test is set, for in the process of memorising the children constantly look away from the book and go over the lines in their own minds. The effort involved in recalling the lines when writing out the piece immediately after learning it is indeed but an extension of a similar series of efforts made during the previous quarter of an hour. When however the reproduction is required of material previously memorised, even though it were only a day or so before, the reminiscence effect is very marked. I conducted an experiment with a class of 43 girls who were given 15 minutes to learn Poe's "Annabel Lee." The poem has a singularly haunting rhythm

and I anticipated a high degree of reminiscence. At the end of two days however the class had improved by one per cent. only, and had written 27·6 per cent. reminiscent lines. When however they were tested two days later they had improved, as compared with the primary test, 20 per cent. and had recovered over 50 per cent. of the lines. The class had never been tested by me before. They in no way expected the tests, and the greatest precaution was taken to prevent surreptitious revision. There were probably several factors that contributed to this result. In the first place, the middle test involved an attempt to revive memories two days old, and the age of association as we have already seen markedly affects reminiscence. Secondly, the rhythm of the piece, appealing as it does to certain motor sensibilities, probably takes a longer time to develop in memory than the ideas involved; for many of the reminiscent lines were corrections of former lines which had not the right swing. The striking feature of the experiment, however, is the abnormal amount of reminiscence which took place in four days, due largely to the stimulating effect of an intermediate test. Other instances appear later where a progressive improvement has been secured, up to a certain limit, by a continuous series of unexpected tests. Each test tends to stir up old associations. And these results seem to throw doubt upon the good faith of the pupils who confessed to have mentally revised the piece at home. What probably happened in the majority of cases was that a certain amount of perseveration had taken place. I have found only one or two instances where the subject tried to fix the lines learnt by writing them down at home; and in these cases the reminiscence was quite abnormal.

We conclude that the effort to recall acts as a strong stimulus to reminiscence; especially when it acts upon memories of at least several hours' standing.

The effort to recall may sometimes by its very intensity seem to defeat its own end. To revert to our typical example of recalling a forgotten name, our very anxiety to recover it blocks the way to success. If we remit the effort and turn the mind to something else, we often find that in a short while the required name spontaneously emerges in the mind. Or if another attempt is made to remember the name, that attempt is successful. The first attempt although apparently unsuccessful was not really fruitless. The response was a delayed instead of an immediate response. The initial failure to recall was possibly due to a persistently active divergent system of ideas, which ceased after a rest to dominate the trend of thought.

By using the phrase 'effort to recall' I do not wish to suggest an irreducible process of searching in a mental void for a lost idea. Reminiscence can never mean anything more than the recovery of a part of a mental system. If we have not only forgotten an idea but also literally forgotten 'all about it,' it is difficult to see how reminiscence is possible at all. "Have you ever received an invitation to dinner and forgotten all about it?" is a question sometimes asked by a jocular friend. If you say "Certainly not," he immediately asks "How do you know?" And there is ground for the scepticism implied. To try to think of a forgotten name is to concentrate the mind on the things that are known to be in any way connected with the name. We think 'about' it. We revive all the available elements of the immediate system of ideas of which the name in question is known to form a part. And it is in this sense that I use the phrase when I state that the 'effort to recall' serves as a stimulus to reminiscence.

Introspective Evidence.

Since reminiscence is a phenomenon most common among children it would be well if possible to obtain information as to what seems to them to happen in their minds. A large number have been questioned on this matter and notes taken of their replies. It was first ascertained whether the subject had thought of the lines in the interval between the two tests—whether it was a case of simple or compound reminiscence. In some classes, not always where the degree of recovery was very high, it was found that from 20 to 30 per cent. of the children had thought about the piece at some time between the two tests. In ordinary cases, however, the percentage rarely exceeded five. The other 95 per cent. had dismissed the matter from their minds as soon as the first test was over, and had not thought about it until they were asked to re-write the lines. How do the latter class of subjects account for the fact that they can remember more after a lapse of time? Children in the infant school were unable to give any sort of explanation. Some of the older children in the senior schools however were occasionally able to give a convincing account. Some, for instance, stated that they believed they could remember more at the first test than they were actually able to reproduce: there were some lines that were 'on the tip of the tongue' and yet could not quite be recalled. At the second test these lines came quite easily. One girl said she was too nervous to write much the first time, and another girl said she was too excited to do herself justice.

Quite a number were good visualisers and were able to 'see' more lines or a more complete scene the second time, e.g.

J. T. improved from 15 to 21 lines in three days. Imagined she saw the lines in front of her.

J. D. improved from 9 to 10 lines in two days, and from 19 to 21 lines in three days. Pictured the paper with the hectographed lines.

W. R. improved from 13 to 16 lines in two days and from 25 to 26 lines in three days. Imagined the scene, but not the words.

E. G. improved from 10 to 26 lines in two days. Visualised lines.

J. P. improved from 33 to 34 lines in two days. Visualised lines.

R. R. improved from 3 to 11 lines in seven days. Pictured the words on the blackboard (the poetry in this case was learnt from the blackboard).

B. G. improved from 9 to 13 lines in seven days. "As I began to write it I could picture it on the paper before me."

It will be remembered that the usual mode of procedure was that the teacher or I should read the piece aloud once before the children began to learn it. It was this auditory impression that seemed to have in a few cases been most persistent. I give two examples of auditory memory :

G. P. improved from 20 to 22 lines in two days. Imagined she heard teacher saying it. Did not picture either the scene or the lines.

A. S. improved from 17 to 21 lines in two days. "I could hear teacher say it."

Others maintained that their imagery was mixed, while a few seemed to be unaware of imagery of any kind.

D. W. improved from 32 to 34 lines in two days. Did not imagine sights or sounds.

Reverting to the five per cent. who had gone over the poetry in their minds, we were able in nearly every case to get a clear account of this active revision. A considerable number of the infants confessed to having repeated it to their mothers. Other typical answers were: "I thought about it in bed"; "I said it over to myself at home"; "I said it to myself when I was going home." One little boy quaintly remarked "I thought it in my head when I got home that night."

The older children were able to describe in greater detail what took place. A few examples of visualisation follow :

J. T. improved from 15 to 21 lines in two days, and from 16 to 23 in three days. Went over it in her mind at home. Imagined she saw the book in front of her and gradually got to see more and more.

The following related experiences similar to J. T.'s.

H. G. who improved from 14 to 19 lines in two days and from 13 to 18 in three days;

J. P. who improved from 15 lines to 16 in two days and from 19 to 26 in three days;

M. G. who improved from 11 lines to 20 in three days; and

P. S. who improved from 13 lines to 15 in two days. These and many others testified to a sort of developing visual image. As they concentrated their attention on it, it became a little clearer and fuller. Generally speaking, this image was of the book, the paper, or the blackboard. They could see the lines and their position on the page. And some of the best memorisers seemed to be of this type. A smaller number of the pupils asserted that they did not see the lines, but saw pictures of the scenes represented, and while looking at these pictures new lines came to mind. I will give three examples of this type:

E. L. improved from 14 lines to 17 in two days: "I imagined I saw the boat and the water." (The piece selected was "The Inchcape Rock.")

M. H. improved from 16 lines to 19 in two days. Pictured the scene.

L. T. improved from 15 lines to 18 in two days and from 15 to 17 in three days. Said the piece to her mother and while so doing could picture the scene described.

A still smaller number testify to imagery such as that experienced by M. H. who improved from 25 lines to 27 in two days. In thinking it over at home she imagined she could hear her teacher saying it.

A few miscellaneous cases are appended:

J. M. improved from 19 lines to 20 in two days and from 29 lines to 32 in three days. Repeated the pieces to her sister once. Not aware of images. Said the sense alone helped her.

M. C. improved from 16 lines to 20 in two days. "I thought of lines and then thought of other lines that would make sense with them."

C. W. improved from 14 lines to 32 in two days. "I said it over and over again at home until I got the rhymes right."

L. F. improved from 26 lines to 32 in two days. She said she built it up from the rhymes. She was helped by being able to picture some of the lines.

In contemplating the whole of the testimony given by these children, one cannot but be struck by the seeming preponderance of visual imagery, the paucity of reference to auditory images, and the entire

absence of reference to kinaesthetic experiences. The first type of imagery is however the easiest to detect, and the last type so difficult that it is not surprising that it should have escaped the notice of children. It cannot therefore be supposed that visual experiences are so important a factor in mnemonic recovery as the evidence of the children would seem to indicate. For in the infant schools and in the schools for the feeble-minded the passages of poetry were learnt by listening or by oral repetition, and the degree of reminiscence manifested in these cases was very marked. Moreover the individual subjects referred to by initials above were set another test which involved the learning of the poem by listening only, and it made practically no difference to the percentage of recovery achieved. It is not contended that the possibility of visual imagery is by this means precluded, for the spoken word may serve as well as the written word as a cue to the picturing of a situation and may possibly succeed in calling up a visual verbal image; but the visual perceptual stimulus is lacking, and the recalling of the actual distribution of the words on the printed page is rendered impossible. We conclude therefore that there is no special type of mental imagery which does not participate in the process of reminiscence, and that we have no reason for supposing that any one type is more specially concerned therein than another.

Correlation of Reminiscence with General Intelligence.

After due allowance has been made for differences due to environment and special training there still remain marked individual differences in capacity for reminiscence—differences which can only be ascribed to congenital endowment. Just as children of the same age vary enormously in their ability to learn by rote, so do they vary enormously in their ability to revive ‘faded’ experiences. And it remains to discover whether this specific ability is necessarily connected with other abilities, and particularly with what is commonly known as general intelligence. I am not here concerned with discussing the nature of general intelligence, or indeed with maintaining that in its ultimate analysis such a thing exists at all as a unitary entity apart from the specific abilities by which it is supposed to be manifested and measured. The term does however connote something to the plain man; and the ordinary schoolmaster, although he is rarely prepared to state what he means by intelligence, is always ready to arrange his pupils in the order of their intelligence.

His judgment is mainly, but not entirely, based on success in the various branches of school study. He modifies the class list by considerations of initiative, resourcefulness and rapidity of comprehension; in fine, by the capacity to deal effectively with novel situations. If by intelligence be meant mere amount of knowledge, my experiments seem to show that reminiscence, so far at least as it is concerned with recently acquired material, is inversely related thereto. It is as a rule the empty head that shows the most reminiscence; and indeed whatever meaning we give intelligence, we find ground for the belief that a high percentage of reminiscence is a sign of mental weakness. Among very young children, mentally defective children, and backward or retarded children, reminiscence is abundantly manifest. Five classes in mentally defective schools were tested orally in the same way as infants. After two days the following percentages of improvement were shown: 40, 43, 55, 44, 39. The degree of reminiscence (which was not calculated) was of course higher still. The last three classes contained boys of nearly sixteen years of age. One lad of fifteen could remember only two lines after 20 minutes' learning, but two days later he was able to repeat the whole poem of 20 lines.

The same feeble initial grasp of the lines, together with later success, is manifested among children who are backward in their school studies. This is strikingly exemplified in the infant schools which retain the children until they are eight years of age. The classification of scholars is in these schools mainly based upon age, and children of seven are as a rule placed in what is known as Standard I. It often happens that many of these children, either through lack of previous school instruction, or through illness, or natural dulness, are much below the normal in scholarship and are placed together in one class. The amount of mnemonic improvement in this class is considerably higher than in the parallel class of brighter children. Out of 11 experiments which have been tried with classes of this kind, in ten instances the retarded class showed more reminiscence, and generally very much more, than the brighter class of the same age. Add to this the fact that reminiscence diminishes with increasing age, and we seem to be driven to the conclusion that reminiscent activity, so far as it relates to recently acquired material, varies inversely with the extent of the subject's general mental equipment.

The case is not however really quite so simple as this. As has already been pointed out (p. 31), we must distinguish between absolute and relative reminiscence. Stupid children learn but slowly, and although,

relatively to the amount learnt, they recover more than bright children, yet absolutely they recover less. Mentally defective children, as far as memory is concerned, seem to behave like children many years younger. For instance, 34 weak-minded children between the ages of nine and twelve, were tested in the same way as infants. They initially learnt less than four lines and recovered less than two. The percentage of reminiscence was a little over 40. Their memories thus proved to be worse than those of normal children of six years old. In a school for elder mentally defective boys where the ages ranged from fourteen to sixteen, the results were much better. 86 of these children were tested orally with 20 lines of poetry. Initially they learnt an average of about nine lines and they recovered about four. This is somewhat equivalent to the performance of children of about nine or ten when they are tested orally.

Attempts have been made to find the correlation between the degrees of reminiscence shown by the pupils in a class with their general intelligence as estimated by their class teacher. Both Spearman's formula for ρ and Pearson's formula for r were used; but the results for different classes varied considerably, and in some cases were contradictory. Indeed there were so many factors involved that without making corrections for the more important of them it seemed impossible to arrive at reliable results. One of these factors was the nature of the frequency-distribution. It had been assumed that in respect of intelligence the steps between the individuals were equal, giving a rectangular distribution. But it is highly probable, as Professor Karl Pearson has pointed out, that the frequency-distribution of intelligence is not rectangular but Gaussian; in which case more reliable figures would be obtained by calculating the correlation ratio η^1 than by finding the value of r . For this purpose a series of six tests for reminiscence was set to a mixed class of 50 children between 10 and 11 years of age, and averages were taken of the six results. The teacher of the class then arranged the names of her pupils in four groups according to their intelligence, and the correlation ratio η between intelligence and rapidity of learning, intelligence and reminiscence etc. was calculated

¹ The correlation ratio η , although it has been little used in psychological work possesses certain advantages over the coefficient r . It is more general, it makes no assumption as to the forms of distribution of the variates, it allows for the numbers in each group, and it measures the correlation when the regression is curvilinear.

See Karl Pearson, "On the Theory of Skew-Correlation and Non-Linear Regression." *Drapers Company Research Memoirs*, Biometric Series II. pp. 9 sqq.; and W. Brown, "The Essentials of Mental Measurement," pp. 57—59.

by means of the formula

$$\eta^2 = \frac{\sum n(y - \bar{y})^2}{N\sigma_y^2}$$

where $\bar{y}$ is the general mean of the characteristic correlated with intelligence, σ_y its standard deviation, y the mean of any one array of that characteristic, n the number of observations in that array, and N the total number of observations dealt with. It will be observed that the sign of η cannot be determined from the formula. In the tables that follow the negative sign is given in cases where it is seen that the means of arrays increase with a corresponding decrease in intelligence.

The probable error was calculated by means of the formula

$$\text{P.E.} = .67 \left(\frac{1 - \eta^2}{\sqrt{N}} \right).$$

The results for the class in question are set forth in Table XIV.

TABLE XIV¹. *Class of 50 children. Average age eleven years.*

Intelligence group	Mean rapidity	Mean absolute reminiscence	Mean percentage reminiscence	Mean percentage retention
A (9)	13.88	2.58	18.28	70.37
B (17)	11.57	1.90	16.30	70.09
C (9)	10.86	1.45	13.53	73.78
D (15)	8.57	1.73	21.44	59.00
	$\eta = .64 \pm .06$	$.41 \pm .08$	$.37 \pm .08$	$.46 \pm .11$

The intervals between the primary and secondary tests varied from one to four days. The two-day experiment and the three-day experiment were made twice.

Table XV gives similar results obtained by treating the data supplied by the tests to which Chart 10 refers.

TABLE XV. *Class of 43 children. Average age 13 years 9 months.*

Intelligence group	Mean rapidity	Mean absolute reminiscence	Mean percentage reminiscence	Mean percentage retention
A	21.27	3.59	16.63	76.36
B	19.40	2.95	15.64	75.90
C	16.13	2.79	15.80	71.06
D	23.27	3.67	16.34	75.14
	$\eta = .45 \pm .08$	$.26 \pm .09$	$.06 \pm .10$	$.21 \pm .10$

¹ In Tables XIV, XV and XVI the amount produced at the primary test, plus the amount re-remembered, is taken as a measure of the amount learnt, and all the percentages are calculated on this basis. They are accordingly lower than those I have given elsewhere.

The 80 training college women who were tested with the "Ballad of John Nicholson" had been arranged by the College authorities in four groups on the basis of their success at the examinations held at the end of their first year of training. The results for the various groups are given in Table XVI.

TABLE XVI. *Class of 80 Training College students.*

Intelligence group	Mean rapidity	Mean absolute reminiscence	Mean percentage reminiscence	Mean percentage retention
A	30.42	1.92	6.29	70.82
B	29.06	2.72	9.62	63.60
C	23.90	2.44	11.08	57.97
D	22.05	3.50	17.32	50.47
	$\eta = .38 \pm .06$	$-.23 \pm .07$	$-.35 \pm .06$	$.36 \pm .06$

One fact stands out clear and unmistakable. Those two memorial qualities which are commonly regarded as abilities—rapidity in acquiring and tenacity in retaining—are directly correlated with each other and with general intelligence. When however reminiscence is considered, the tale told by the above statistics is not so unambiguous. The Training College results alone tend to confirm the hypothesis suggested by the researches among mentally defective children—the hypothesis that a high degree of reminiscence is indicative of a low grade of intelligence. But the results for normal children do not fully support this view. For children of the same age there is a distinct positive correlation between absolute reminiscence and intelligence. The correlation with percentage of reminiscence is lower. It is indeed doubtful whether it is positive at all.

When the results for the ten most intelligent pupils in a class are compared with those for the ten least intelligent, one generally finds strong support for the general view that absolute reminiscence is greater among the more intelligent children, but relative reminiscence less. For example, in a class of 43 children who were tested with "The Wreck of the Hesperus," the ten most intelligent learnt altogether 216 lines in a quarter of an hour and after two days recovered 48; while the ten least intelligent learnt 51 and recovered 24. Other classes have been treated in the same way, and generally, but not always, the results have supported the same inference.

We have already seen that when classes differing widely in intelligence are compared the same tendencies are apparent. In the case of the feeble-minded boys over 14, however, the number of lines recovered, viz. 4, was in excess of the average for normal children, which

is not higher than 3 even at the most favourable age. It is probable however that if the mentally defectives were tested on paper instead of orally the number of reminiscent lines would be less.

We hesitate to formulate a general statement as to the relation between intelligence and reminiscence. Apart from unaccountable individual differences, age seems to be the most important factor that determines the degree of reminiscence. As the child gets older it cannot be asserted that he grows less intelligent, and yet his liability to reminiscence steadily diminishes. It is probable indeed that after the age of 35 or 40 the power to re-remember recently acquired material practically disappears. It is immaturity therefore rather than lack of intelligence that entails a high measure of reminiscence. Mentally defective children behave, in respect of reminiscence, like children many years younger; and the backward children who are regarded as normal manifest the memorial traits of children a few years younger.

The Reliability and Variability of the Results.

It may reasonably be asked with what degree of confidence may the statistics which I have given be accepted as a measure of the recovery of lost memories without recourse to outside help. There is, it must be confessed, no absolute guarantee that none of the children had access to the poems and revised them. All we can say is that access was highly improbable. In no case was it possible in school: if it happened at all, it happened at home. But with much of the material used surreptitious revision could not possibly have taken place; and the degree of reminiscence in these cases was certainly no lower than in the cases where the children might have re-learnt the piece at home. In many of the schools the children came from such poor homes that no books of any kind were likely to be found therein, and in these schools reminiscence was quite as marked as in the schools attended by more fortunate children. Finally there is the evidence of the children themselves. When questioned on the matter a few confessed to have re-read the poem at home. The figures in these cases were cancelled.

Remarkable individual differences were revealed in powers of learning, retaining and recovering; and these differences seem to be accentuated as the pupils grow older. For instance, a Training College student 25 years old could learn only three lines of Matthew Arnold's "Saint Brandan" in 15 minutes, while another student of the same age learned 33. The latter student remembered 29 at the end of two days; but another student who was able to write eight correct lines after

memorising could only write two at the secondary test. While about half the students who were tested with this poem showed no reminiscence at all, some wrote as many as five reminiscient lines.

Still more striking were the differences displayed by the 80 women who tried to learn in 15 minutes 48 lines of the "Ballad of John Nicholson," and were given the secondary test after a week's interval. One student wrote 47 lines and 45 lines, and another wrote 47 and 42 at the primary and secondary tests respectively. On the other hand one of the subjects could write only two lines at first, but she increased them later to ten. One student improved her record from 19 to 29 (with 11 reminiscient lines); while another deteriorated from 15 to 2 (with one reminiscient line); and another from 29 to 1.

In a class of 53 children six years of age the number of lines learnt in a quarter of an hour varied from 1 to 9, and the number of reminiscient lines from 0 to 6.

When we consider classes instead of individuals the degree of variation is naturally much less. Table XVII gives the mean variations of some of the classes involved in the experiments with ballad poetry, the results of which are recorded in Chart 6.

TABLE XVII.

No. of classes	Days' interval	Average reminiscence	Mean variation
22	1	20.5	7.2
23	2	23.2	8.7
13	3	19.9	6.6
19	4	20.5	7.4
10	5	21.1	7.9

In each case too the median exactly or nearly coincides with the mean. The mean variation of these means is considerably less than 1.

When therefore more than 500 subjects of about the same age are tested and reasonable care is taken to keep the conditions somewhat similar, the results may be taken as fairly representing what normally takes place. And in my more important and extended experiments the number of subjects tested has exceeded that number.

When the same class has been tested again with a similar poem and the same interval, there has often been a considerable difference in the results. Apart from a desire to interfere as little as possible with the school time-table it has in point of fact been found impossible to keep constant even those conditions which are known to be important. No two poems, nor even different parts of the same poem, are of equal interest to the children. We cannot secure that the children should be

equally fresh on two occasions. And on the second occasion there is a psychological factor which is absent on the first: the setting of a secondary test is at least suspected after it has once taken place.

In marking the papers in the poetry tests, the line has all through been taken as the unit: if the line is not absolutely correct, except in the matter of spelling, it counts for nothing. Although this method has the advantage of simplicity and uniformity, leaving no room for variability of judgment in the marker, yet it is obviously not without defects. It may well be argued that if a subject reproduces a line which is almost correct he ought to get credit for it; and if a line partially correct at the primary test is wholly correct at the secondary test, the correction should not score as one reminiscent line in the same way as a line which appears for the first time at the secondary test. I have accordingly marked some of the sets of papers in two ways and compared the results. First they were marked on the line-unit method. Then they were marked again, counting each line absolutely correct as one, each line nearly correct as $\frac{1}{2}$, and each line which was only roughly correct as $\frac{1}{4}$. On this basis it was of course found that the number scored at both primary and secondary test was larger than on the line-unit basis; but it was not proportionately larger. The primary score was increased somewhat more than the secondary score. The score for absolute reminiscence however remained virtually the same for both methods.

If the above fractional method, as it might be called, were used, it would, so far as I can estimate, raise the unit method score for the primary test by about 25 per cent.; and, since absolute reminiscence remains the same, the percentage of reminiscence would be reduced by about one fifth.

The curves I have given for poetry would however retain all their essential features; and the inferences I have drawn would remain unaffected.

Kindred Phenomena.

Ever and anon in the literature of psychology one comes across references to phenomena either the same as or similar to those of which I have given an account. First and foremost comes Plato's celebrated theory of Reminiscence as expounded in the *Phaedo* and the *Meno*. Among modern writers Wm. James may be quoted: "There are many irregularities in the process of forgetting which are as yet unaccounted for. A thing forgotten on one day will be remembered on the next.

Something we have made the most strenuous efforts to recall, but all in vain, will, soon after we have given up the attempt, saunter into the mind, as Emerson somewhere says, as innocently as if it had never been sent for. Experiences of bygone date will revive after years of absolute oblivion, often as the result of some cerebral disease or accident which seems to develop latent paths of association, as the photographer's fluid develops the picture sleeping in the collodion film¹."

"It must be noticed that the growth of structural modification in living matter may be more rapid than in any lifeless mass, because the incessant nutritive renovation of which the living matter is the seat tends often to corroborate and fix the impressed modification, rather than to counteract it by renewing the original constitution of the tissue that has been impressed. Thus, we notice after exercising our muscles or our brain in a new way, that we can do so no longer at that time; but after a day or two of rest, when we resume the discipline, our increase in skill not seldom surprises us. I have often noticed this in learning a tune; and it has led a German author to say that we learn to swim during the winter and to skate during the summer²."

Those who have experimented on the effect of practice on mental work (notably Kraepelin and Meumann) have invariably noticed the improvement that follows a period of rest.

M. Bourdon has given an account of experiments he has made on the fixation of habits³. The subjects were practised in work with the ergograph, in marking certain letters in a page, in counting as rapidly as possible 2, 4, 6, 8, etc., and in many other forms of mental and physical work. He found in some instances that after several days' or even months' intermission of practice improvement in skill was manifested. Some notable contributions to the psychology of learning have recently been made in America, particularly by Messrs E. J. Swift and W. F. Book. Mr Swift gives instances of increase in skill in tossing and catching balls, during 30 days when no practice at all took place⁴; and again of improvement in two subjects after an intermission of 633 days in one case, and 463 days in the other⁵. Mr Book records an instance of considerable improvement in the ability to use a typewriter after a rest interval of a year and a half⁶. Mr A. Cleveland in discussing the psychology of chess asserts that short periods of rest from chess practice, varying with the individual from a few weeks to several months,

¹ *Principles of Psychology*, I. 681.

² *Ibid.* I. 109—110.

³ "Recherches sur l'habitude," *L'année Psychol.* 1901, VIII. 327—340.

⁴ *Amer. J. of Psychol.* XIV. 221. ⁵ *Ibid.* XVI. 131—133. ⁶ *J. of Educ. Psychol.* I. 185.

may cause a noticeable increase in skill¹. Mr Cyril Burt has shown that improvement in mirror drawing can take place after three months' intermission of practice².

Indeed all those who have studied either directly or indirectly the psychology of the pause have discovered that the traces left by training do not persist unchanged during the pause, but undergo processes of development and decay.

An interesting study of reminiscence (although he does not use this term) appears in Mr Arthur Lynch's recent book on Psychology³. He analyses in detail what happens when one tries to recall a name that has slipped one's memory. He traces step by step the way in which various elements in the name return to recollection. First perhaps the initial letter appears; then a vague apprehension of the number of syllables, and of a group of words that resemble it; then perhaps a conviction that certain vowels or consonants appear in the name; and so step by step through fluctuating feelings of certainty and uncertainty, and often after repeated efforts extending over days or even weeks, the name at last finds its way into clear consciousness and is recognised with confidence as that which was sought. The inference he draws is that even such a simple thing as the name of a person is not a unitary thing in memory. Every letter, every syllable, the general appearance of the word on paper, the sound, and indeed every item or relation that may be attended to separately forms its own associations, and may under certain conditions be recalled independently of the other items or relations which constitute the whole.

Mr Lynch also gives an account of the remnants left in his mind of poems learnt years before, and never revised. He has an interesting theory that the passages that tend to remain are the really inspired passages: those that disappear are the mere connective tissue. In the memorising of mathematical formulae he shows that what is remembered to-day may be forgotten to-morrow and recovered the day after to-morrow; that indeed obliviscence and reminiscence are constantly going on side by side⁴.

Dr W. H. Burnham uses the term dissociation (generally applied to disorders of personality) to describe simple cases of normal forgetfulness⁵. Temporarily forgetting a person's name is an instance; another is forgetting something that you have planned to do during the day.

¹ *Amer. J. of Psychol.* xviii. 298.

² *Child Study*, iv. 110.

³ *Psychology: A New System*, i. Chap. x.

⁴ *Idem*, 290—301.

⁵ *Amer. J. of Psychol.* xiv. 118—132.

You remember that there is something which you proposed doing; but try how you will, you cannot remember what it was. It is a case of failing to establish an associative link between the present current of thought and the task in question.

Numerous instances of this kind will occur to the mind of the reader. One of the most common happens in ordinary conversation. You are discussing with a friend a matter of interest to both, and while he is speaking something flashes across your mind which you feel very anxious to tell him. It is pertinent to the topic, and will, you feel sure, interest him. You refrain however from interrupting him, and listen till he has finished. Then when it comes your turn to speak, you are chagrined to find that you have completely forgotten what you wanted to say. After you have parted from your friend, it will probably, in accordance with the usual irony of things, come back to you. There is in this case again a temporary severance of a system of ideas from the system dominant in consciousness. Reminiscence means restoring in some way the bond of association with the current system.

When we leave the region of common experience and explore the realm of the abnormal, we find abundant evidence of reminiscence taking place on an enormous scale. We find instances of whole systems of ideas passing for long periods quite beyond the possibility of recall. The study of hypnotism, trance-mediumship, double personality, and the various kinds of amnesia arising from hysteria, epilepsy and insanity, reveals abundant examples of this kind. But with none of these do I propose to deal here; I limit my enquiry to normal conditions.

Thus it appears that the phenomena which might, without doing violence to the meaning of the term, be included under Reminiscence, are numerous and varied; from cases of recovering the memory of a word, to cases of recovering the memory of a language; and from cases where reminiscence seems to be purely psychological to cases where it seems to be almost purely physiological.

*The Extension of the Doctrine of Psychical Dispositions necessitated
by the Facts of Reminiscence.*

Some such theory as that of psychical dispositions as propounded and elaborated, for instance, by Professor Stout, is necessary if we are to explain mental happenings without reference to the brain. Every experience after it is over leaves behind it some sort of condition upon which its revival depends. This is ordinarily called a psychical

disposition. It represents the idea when the idea itself is outside the sphere of consciousness. When the disposition is excited the corresponding experience is revived in consciousness. "It is necessary to realise clearly that psychical dispositions form an indispensable factor in mental process throughout conscious life. All change and transitions depend on the excitement of dispositions previously unexcited, or not excited in the same manner and degree.....We may even go further than this. The mere retention of a presented content in consciousness involves the continued excitement of a psychophysical disposition, and is conditioned by its excitability¹." These dispositions tend to form systems of various degrees of complexity. When they are maximally excited they determine the focal content of consciousness, when minimally the marginal content. When they are not excited at all they in no way influence the immediate experience of the subject. All this seems to be involved in the theory, and it is further tacitly assumed that when a system of dispositions is not concerned in maintaining the actual content of consciousness it undergoes either no change at all, or a change for the worse². It tends in fact to disintegrate, and obliviscence follows. The degree of excitability of the disposition is increased by one means only—by actually exciting it. If this is so, then the facts we have been considering force us to believe that the excitement of a disposition does not die out immediately after the corresponding experience passes out of consciousness, but continues in a lower or modified form for some days after, and thus tends to arrest and reverse the process of dissolution. Some forms of reminiscence would, on this theory, be due to the gradual increase in the excitability of dispositions arising from their continued excitation after their conscious correlates have disappeared from the field of consciousness.

Stout further states: "When part of a complex disposition is excited the whole tends to be excited in the same manner and degree³."

The peculiar effect of an attempt to remember upon the degree of reminiscence which supervenes is explained by this principle if we assume as before a prolonged subliminal excitation. When part of a poem is revived and the rest forgotten, the dispositions underlying the forgotten part are in some degree excited although not sufficiently to

¹ *Analytic Psychology*, I. 23, 24.

² It may be pointed out that dispositions are innate as well as acquired, and that I am not here referring to those complex congenital dispositions which lie at the root of our emotional life, but merely to those dispositions upon which our specific memories depend for their revival.

³ *Idem*, I. 270.

bring their correlates into consciousness. This excitation however by its continuance gradually increases the excitability of ineffective dispositions so that after a lapse of time the attempt to remember more is at least partially successful. The propagation of the excitement from part to whole again explains the peculiar reminiscent effect of brooding over old memories. The older dispositions even though less excitable are probably more closely welded together into coherent systems, so that excitation of some parts of these systems is eminently liable to produce reminiscent activity among other parts of the same systems.

But what precisely constitutes membership of a system of dispositions? How is it to be determined what elements are included and what excluded? There is indeed a sense in which the whole make-up of the individual mind may be regarded as a unitary group of psychical dispositions; and any subdivision into smaller groups or systems such as are referred to above can only be based, if looked at from a mechanical point of view, upon relatively closer cohesion among its members than between them and the members of different systems. But dispositions are not merely associated according to the law of contiguity. A dispositional system may become a system through the mere fact that the mind regards the corresponding contents of consciousness as a system. A memorised poem is a case in point. It may be that irrational associations by contiguity are mechanically stronger between some of the words and irrelevant experiences than between the words of the poem itself. There are moreover logical systems of relationships whose divisions cut across those between other systems, as indeed the other systems cut across one another. Indeed the continuity and fluidity of thought indicate that the systems into which mental dispositions group themselves overlap and interpenetrate, and are constantly shifting and changing their boundaries.

This being the case, where are we to fix the limits of the reminiscent activity generated by the excitation of a limited number of dispositions? Such activity is of two kinds. First, that which takes place in the dispositions effectively excited—that is, excited sufficiently to bring the corresponding experiences within the field of consciousness—and secondly that which takes place in other dispositions which are in some way associated with them. And since there is some degree of coherence between all the mental dispositions, it seems to point to the conclusion that the whole mind tends to benefit in some degree, in the way of increased reproducibility of its knowledge, by the revival of any portion of its store. It is at least demonstrable that such improvement takes

place in the elements most closely connected with the revived elements. This fact throws some light upon the difficult problem of formal training. The main concern of the investigator of this problem is to ascertain what, if any, are the factors that are transferred—the factors that ‘overflow’—from the function specifically exercised, and to what extent the overflow takes place. Here, in the fact of increased aptitude for reproducing knowledge—in the improved availability of one’s mental equipments—is to be found at least one factor that passes beyond the limit of the exercised function. There seems indeed to be some justification for the popular view that the mind is kept bright by exercise; not merely bright in that particular phase, but in every other phase of intellectual activity.

It is probable that the concept of psychical dispositions was intended to supersede the concept of subconsciousness. If however changes in the excitability of these dispositions in the direction both of increase and of decrease, take place when their correlates are not within the field of consciousness, we are still driven (if the principles of explanation are to be complete on the psychical side) to accept what virtually amounts to subconscious mental activity. And the question arises: is this activity merely memorial—merely a strengthening or weakening of associations—or is there also a change in the organisation of these memories? Does any form of apperception or mental synthesis take place below the threshold? There are certain facts which point to an affirmative reply. The sudden discovery of a dweller in a strange land that he understands much of what the people about him are saying although he has made no attempt to learn the language; the ability to solve readily in the morning a problem that completely baffled one the evening before; the almost explosive suddenness with which, after days or weeks of apparently fruitless study of a difficult problem, the light of clear understanding bursts upon the mind; the genesis of certain works of genius—all these phenomena lend support to a belief that elements are combined and elaborated subconsciously and the products handed bodily over to the conscious mind.

It is nevertheless a plausible theory that what takes place subliminally is merely reminiscence. The ideational data are more readily presented to consciousness and the synthesis that follows is so rapid that it seems as though the data had never been presented at all in an unorganised form.

Leaving now the purely psychological side of the question, let us consider whether the use of physiological concepts will lead to profitable issues.

The Physiological Conditions of Reminiscence.

I. *The removal after a lapse of time of inhibitions which arise during the process of learning.* A study of Chart 6 makes clear the fact that the amount of poetry learnt is not represented by AC , nor yet by AD , but by $AC + BD$. So much at least has been learnt, and possibly more. For obliviscence may have taken place among factors which were reminiscent on the previous day. If then $AC + BD$ was the amount actually learnt, the obvious question is: why was this amount not reproducible at the primary test? Instead of asking why is any given mind capable of recovering lost memories, a question more pertinent at present is: why were the memories lost at all? The fact of reminiscence is indeed only a mark of mental power when it is compared with complete forgetfulness; compared with complete and ready remembrance it is a mark of weakness. For the cause of this weakness it would be well to seek first at the beginning—at the time of learning.

(a) *Recovery from fatigue.* It is a plausible theory that after memorising the mind is too fatigued to do itself justice in the initial reproduction. Apart from the fatigue of memory in general, or of any specific kind of memory, it is a matter of common observation that fatigue of any kind, except when it gives rise to unnatural excitement, affects the memory injuriously. When we are tired we forget things. Our vocabulary shrinks to narrow limits and we halt and hesitate in speech. Facts that we readily remember at other times are now beyond the range of recall. After a rest we regain our normal facility of recollection. Is it not possible that the inaptitude for reproduction immediately after memorising is due to the same sort of thing—to the inhibition of fatigue? It is notorious that memorising, especially when the subject works at high pressure, as he did in the tests I have recorded, is a very fatiguing process. Griesbach after his experiments with the esthesiometer ranked memorising exercises with mathematics as the most fatiguing of school pursuits. And although among later experimenters there is a divergence of opinion as to the exact place of memory in the fatigue scale of school studies, there can be no doubt that strenuous memorising is one of the most fatiguing kinds of mental work. Bain indeed was so impressed by this fact (although he contemplated it from the side of the supposed physiological changes) that he constantly refers to it. For example: "Although there is still wanting a careful study of this whole subject, the patent facts appear to

justify us in asserting that the plastic or retentive function is the *very highest energy* of the brain, the consummation of nervous activity. To drive home a new bent, to render an impression self-sustaining and recoverable, uses up (we may suppose) more brain force than any other kind of mental exercise¹."

What evidence have we that the memory exercises which I have been setting actually fatigued the subjects sufficiently to account for the suppression that seems to have taken place? In the first place it is a significant fact that the subjects shown by independent observation to be most fatigable manifest in these memory tests the highest degree of reminiscence. Very young children, and also older children of weak intellect, are notoriously liable to mental fatigue; and they display more reminiscence than any other kind of subject. As they get older and more capable of resisting fatigue they also can readily remember more, and reminiscently remember less. The facts afford presumptive evidence of connexion between fatigability and liability to reminiscence. Another reason for regarding fatigue as a contributory cause is to be found in the fact that as a rule more reminiscence ensued when the learning took place in the afternoon, especially if it was late in the afternoon, than when it took place in the morning. For example, a certain class of girls who manifested 26·6 per cent. and 27·1 per cent. reminiscence as the result of two experiments which involved learning at 3.40 p.m., when set to learn at 10.30 a.m. showed 14·5 per cent. only—a difference which cannot be accounted for by the mere difference in the poems, for the number of lines initially learnt was quite as high in the last case as in the other two cases. Three classes in the same school were tested in the afternoon and given a three days' interval, and again in the morning and given a two days' interval. In each case the reminiscence following the afternoon learning exceeded that following the morning learning although the interval was less favourable. The most remarkable instance of combined retentiveness and reminiscence that I have come across occurred in a class of girls who had previously shown somewhat abnormal powers of memory. On the last afternoon before the summer holidays they were put to learn the first half of "The Wreck of the Hesperus." They learnt on an average $12\frac{1}{2}$ lines in the ten minutes given them. When they returned after the holidays, which lasted nearly five weeks, they were given a secondary test which showed that they had retained 88·2 per cent. and that in addition reminiscence had taken place to the extent of 24·5 per cent. The average number of lines per child was

¹ *Education as a Science*, 23.

now over 14. When however they were again tested with the second half of "The Ancient Mariner" under conditions which were similar except that the learning took place in the morning and that no holidays intervened, the number of lines initially learnt was 14·2, but the amount of retention was only 81 per cent., and the amount of reminiscence was as low as 3·3 per cent. The difference cannot wholly be accounted for by the intercalation of the holidays, for I have convinced myself by independent tests that this has little bearing on either retention or reminiscence. It is difficult to escape the conviction that the marked reminiscence shown on the former occasion is due to the gradual removal of certain hindrances to reproduction which were present at the primary test. One of these, although not the only one, and possibly not the chief one, was fatigue. The explanation given by the girls themselves was that they were excited about the coming holidays and were too "flurried" at the time to remember all they felt they could under more favourable circumstances have remembered.

Further to test the influence of fatigue upon reminiscence, a special experiment was made with two classes in the same school. The learning period (15 minutes) was divided into halves, and in the first class a poem *A* was memorised during the first half, and a poem *B* during the second half. In the second class the order of the poems was reversed. It was thus hoped to eliminate the factor arising from the nature of the piece learnt. If fatigue were the important inhibitory agent one would expect to find less learnt during the second half, but more recovered after the lapse of two days. The actual results bear out this expectation. (See Table XVIII.) The first class contained 35 children of $12\frac{3}{4}$ years old, and the second 31 children of $12\frac{1}{4}$ years old.

TABLE XVIII.

Class	Period	Lines learnt	Percentage of		
			retention	reminiscence	reminiscents
1st	1st half	8·9	84·2	21·2	83
„	2nd „	7·3	95·3	34·6	88·6
2nd	1st „	9·8	96·0	12·9	58·1
„	2nd „	6·9	92·5	15·0	77·4

There is clearly an advantage as regards reminiscence in favour of the second half of the learning period. It is not however very marked; and the actual number of lines recovered by the second class was greater after the first half than after the second.

We find however that there are very serious difficulties in the way of our accepting the fatigue theory as explaining all, or even the greater

part of, the phenomena which I have included under the head of Reminiscence.

1. If fatigue results from 10 minutes' memorising, it is not of that kind of which the subject is conscious; and it is not, so far as I can discover, sufficient to be detected by the common devices for measuring fatigue.

2. If fatigue is present, it must be of a highly specialised kind; for the general fatigue of the day's work and play normally passes away with little children after a night's rest. Reminiscence however takes more than a day to develop completely. Young children although easily fatigued, recuperate rapidly. The kind of mnemonic recovery, however, with which we are dealing seems to be a slower process with children than with adults.

3. Were we to assume the removal of fatigue to be the main cause of reminiscence, it would follow that the longer the time the subject spent in learning the piece the greater would be the subsequent reminiscence; for the amount of fatigue would inevitably increase with the time. Experiments expressly made to test this hypothesis fail to give it any substantial support. A translation of one of Heine's poems containing 16 lines was read over twice to a class of girls. It took about a minute and a half, and it is difficult to believe that the girls were appreciably fatigued thereby. Yet, at the secondary test, which was given three days after learning, they improved by nearly 8 per cent. on the result of the primary test. A more searching series of tests was carried out with four classes of older children and two classes of infants. Three separate experiments were made on each class, with intervals of two days between the primary and secondary tests. The times of learning however differed. In the first case the time was five minutes, in the second 15 minutes and in the third 30 minutes. The results are given in Table XIX.

TABLE XIX.

Class	No. tested	Age	5 mins. learning			15 mins. learning			30 mins. learning		
			lines learnt	percentage retained	% remi- niscence	lines learnt	percentage retained	% remi- niscence	lines learnt	percentage retained	% remi- niscence
<i>A</i>	41	13·2	7·7	79·8	11·0	11·3	86·8	10·0	10·4	81·7	19·3
<i>B</i>	19	13·4	3·4	72·0	28·0	4·3	52·0	32·0	9·0	85·3	23·5
<i>C</i>	32	12·3	6·2	86·0	28·0	6·2	75·0	33·3	13·9	82·7	26·0
<i>D</i>	28	11·8	4·0	68·5	32·2	5·7	67·0	31·2	10·5	66·4	44·0
<i>E</i>	18	7·4	5·7		13·6	5·2		10·6	5·6		19·0
<i>F</i>	36	7·1	2·0		66·7	2·3		68·7	3·4		25·6

This table demands a few comments. Class *A* was tested with pentameters. The first two passages were taken from Goldsmith's "Deserted Village"; and the third from Southey's "At Barossa," written in blank verse. The lines were thus considerably longer than those I have generally used, and in the last case there was no rhyme. Classes *B*, *C* and *D* belong to the same school. In each case the same poem, "King John and the Abbot of Canterbury," was used sectionally for the three experiments. It proved to be a piece where the ideas were far more easily remembered than the exact form of the words. In fact the number of lines nearly correct was so large that for purposes of comparison the results were considered on the basis of neglecting merely verbal errors. On this method of marking the number of lines learnt was in each case more than double the number recorded in the table. The amount of reminiscence was however considerably less; for many of the reminiscent lines were corrected lines and not entirely new lines. The results however did not affect the conclusions here arrived at, and they are consequently not recorded.

Classes *E* and *F* were infant classes and were tested orally. Instead of the amount of reminiscence in these cases the record gives the amount of improvement. In only two instances was a child found to repeat fewer lines at the second test; and in each of these cases one line only had been forgotten. In Classes *E* and *F* we meet a peculiarity referred to elsewhere. They are higher and lower divisions of the same standard.

What conclusions can we legitimately draw from this series of experiments? Let us take the two extreme cases of five minutes' learning and half an hour's learning. If fatigue is an important factor in giving rise to subsequent reminiscence, the amount of reminiscence after 30 minutes' work ought to be much greater than the amount following five minutes' work. In our experiment it was greater in three cases and less in the other three. Taking the averages for the two series we find that there is on the whole more reminiscence after five minutes' learning. It may however quite reasonably be contended that fatigue is not proportional to the time of working, but rather to the amount of energy expended during a given time. It is just possible that five minutes' concentrated work—work at the very highest pressure—will produce more fatigue than half an hour's work carried out with a normal degree of effort. Indeed the number of lines learnt during this period lends colour to this view. In no instance is the amount learnt in fifteen minutes double the amount learnt in five minutes.

Indeed, in one instance it is less. On the whole only one-fifth more was learnt during the longer period. The children were told the length of time they would be allowed for learning, and this no doubt affected their rate of work. When they knew they had only five minutes, they immediately put on a spurt. When they knew they had half an hour, they set about it in more leisurely fashion.

It might therefore be considered fairer to compare the quarter-hour test with the half-hour test. Here there is some reason for thinking that the intensity of the energy expended over the two periods was fairly even; for in three of the classes the amount learnt in half an hour was about double that learnt in a quarter of an hour. It may however be pointed out that the middle passage of the poem learnt by these three classes seemed to be much harder to remember than the other two. However that may be, we find that even in this case three classes recovered more after the longer period of learning, and three recovered less. Taking the aggregate marks we find again that from the point of view of reminiscence the advantage is on the side of the shorter learning period.

As an outcome of this experiment one thing is clear, and that is that recovery from fatigue is, at least, not the chief factor in determining the amount of reminiscence.

4. A still more serious objection to the fatigue theory as an all-embracing principle of explanation is to be found in certain instances of compound reminiscence. It may be argued that on the following day after learning at least the bulk of the fatigue would have passed away, and but little reminiscence would have followed a test given on that day. But this is contrary to what actually takes place. A class of 55 boys of between 10 and 11 years of age were given one Tuesday morning ten minutes to learn "The Peel Life-boat" by T. E. Brown. They were not tested at all on that day, but were given the first test on the following morning, i.e. exactly 24 hours after learning. The primary test was in fact a deferred test. The secondary test was set on the Thursday morning at the same time; and I expected but little reminiscence to be shown. It amounted, however, to the surprising figure of 41·7 per cent., the class as a whole having improved by 29 per cent.

This experiment was repeated with a class of 43 girls of twelve years of age. The poem selected was "The Wreck of the Hesperus." After they were given fifteen minutes to learn it, I heard a few of the best girls recite what they had learnt, in order that they should not

suspect a further test. This was on a Monday morning. On the Wednesday morning they were required to write it out; and again on the Friday morning. By Wednesday all fatigue would surely have passed away. And yet the results on Friday showed an improvement of 22 per cent. on the Wednesday results. The percentage of reminiscence was 27. Similar results were obtained in two other classes.

The same sort of thing occurs in what I may call 'serial' tests. In this experiment there is only one learning or primary test, the others are all secondary, or rather secondary, tertiary, etc. Three classes in a school attended by rather poor girls were given "The Burial of Sir John Moore" to learn on September 25th and immediately tested. They were tested again on September 27th, and again without revision on the 30th. Thus there was an interval of two days, an attempt at reproduction, and then a further interval of three days. The first class during the first interval manifested 33 per cent. reminiscence, and a further 19 per cent. during the second interval. The corresponding percentages for the second class are 34 and 18; and for the third and youngest class 23 and 26.

Another school attended by a much better class of children was tested in the same way. The poem in this case was "Hohenlinden," and the interval between the primary and secondary tests was one day, and the interval between the secondary and tertiary one day. The amount of reminiscence in the first class during the first interval was 13 per cent. and during the second 12 per cent. The corresponding numbers for the second class were 65 and 19, and for the third class 41 and 12. I am at a loss to account for the extraordinary amount of reminiscence during the first day after memorising.

Four classes of Infants tested in the same way displayed a progressive tendency to improve with periodical tests up to about 10 days after learning. Now all this is quite incompatible with the theory that reminiscence is entirely the result of recovery from fatigue.

5. Finally, the fatigue hypothesis cannot account for the gradual resuscitation of old memories.

(b) *The passing away of retro-active inhibition.* This well-known process is clearly described by Dr C. S. Myers in the following passage: "Experiment has shown that when an association $c-d$ is learnt after an association $a-b$ has been formed, the formation of $c-d$ tends to diminish the strength of $a-b$. This retro-active inhibition, as it is called, disappears in the course of time, so that a certain improvement in the strength of the first-learnt association then occurs. We may

thus explain the fact that if a series of syllables be learnt and tested a few minutes after learning, a smaller number of scores and of short scoring times is obtainable than when a series of like difficulty is learnt and is tested after a somewhat longer interval since learning¹."

That some such inhibition exists is at least not disproved by a scrutiny of the reminiscent elements in the poems learnt. What precisely are the lines of poetry which are recovered? Do they come at the beginning of the passage learnt, or in the middle, or at the end? In point of fact they are fairly evenly distributed. The new lines appear generally about the middle or near the end. The corrected lines are more frequent near the beginning. The reminiscent lines in "Annabel Lee" were analysed thus: The 6th and 12th lines were recovered eight times, the 11th seven times, the 1st and the 20th six times, the 3rd, 10th, 13th, 15th, and 16th five times, etc. There was no line in the first three stanzas that was not recovered at least once.

In the first class that dealt with the 32 nonsense syllables (see page 25), every syllable was recovered by somebody except the 4th and 27th. The most frequent were the 19th and the 25th. After that came the 6th and 7th.

In the second class dealing with these syllables each word was recovered except the 11th. The most frequent were the 7th and the 26th.

In the experiment with "The Peel Life-boat" (see page 61) the line most frequently reminiscent was the first. In 29 instances was it given incorrectly at the primary test and correctly at the secondary test.

In the visual test (see page 26) every diagram was recovered except the 1st and the 9th. Considerably the most frequently reminiscent was the 8th—the triangle in a circle.

All this shows that it is not the items that are learnt last that are most frequently forgotten, or most frequently recovered. The associative links established at the early stages of the learning are just as frequently strengthened during an interval of rest as those established at the later stages of learning.

Most of the objections however that have been urged against fatigue as an explanatory principle hold with equal force against retro-active inhibition.

Retro-active inhibition seems to pass quickly away. I have tried to discover the retro-active effect of severe study upon the results of

¹ *An Introduction to Experimental Psychology*, 81.

memorising that took place immediately before. Children in two schools were set to learn the meanings of certain Latin words at 9 a.m., noon, 2 p.m., and 4.30 p.m. After the 9 a.m. and the 2 p.m. learning periods the children were immediately given tests in arithmetic or composition which would require concentrated thought. After the other two learning periods the children were dismissed from school and a period of mental relaxation followed. When tested the next day, whatever retro-active inhibition effect the arithmetic and composition may have had seemed to have passed away.

But the term 'retro-active inhibition' may be interpreted in a larger sense. It implies that all new mental acquisitions throw a shadow over all our previous acquisitions, and that consequently the older the knowledge the further it is thrown into obscurity, for it suffers from the cumulative effect of all subsequent learning. If that be so, then indeed the re-learning of old material sets up reminiscent activity by initiating a process which leads to the gradual removal of retro-active inhibition. And obliviscence can no longer be considered a positive process of decay of psychical dispositions, but a mere over-laying of these dispositions by the impeding residua of subsequent mental processes. But the plain facts of experience are against such an assumption. Obliviscence, as is well known, is most rapid immediately after learning; and older knowledge is not by any means the least amenable to facile reproduction. But there are other modes in which retro-active inhibition may be supposed to operate. It might pass away with the process of time, and be imposed merely on more recently acquired knowledge. But this form of the doctrine would fail entirely to account for the fact that it is the older material that is the more liable to be re-remembered. Indeed whatever interpretation we give the term we can find in it no satisfactory clue to the secret of reminiscence.

(c) *The removal of other obstructions.* Although the presence of fatigue and of retro-active inhibition is insufficient in itself fully to explain the inability to write as much at the primary test as at the secondary, it is just possible that there are other inhibitions which complete the explanation. Many of the children for instance testify to being "flurried" or "excited" at the primary test. But although it will be admitted that over-excitement sometimes lowers one's capacity to recall, it was found in these experiments that reminiscence took place in normal degree when there was no indication of excitement. Indeed no impeding factor that I could think of was, when put to the test, found to be an essential, or indeed an important, condition of reminiscence.

The whole theory of inhibition therefore as a basis of explanation requires to be submitted to the test of more searching experiments. The experiment which I am now about to describe, I devised and carried out with the sole object of discovering, if possible, the disabilities that arise during the learning of a series, and the distribution of reminiscent items.

The memory value of position in a series.

It was desirable for this investigation to find a series of associated pairs, each pair being of equal interest and memorableness. Without falling back upon the arbitrary associations between figures, letters or nonsense syllables, the nearest approach I could think of was a vocabulary in an unknown tongue with English equivalents. I accordingly selected the following 20 Latin nouns: (1) *hiems*, winter; (2) *gladius*, a sword; (3) *spes*, hope; (4) *pollex*, a thumb; (5) *silva*, a wood; (6) *ovis*, a sheep; (7) *mensa*, a table; (8) *lupus*, a wolf; (9) *collis*, a hill; (10) *fax*, a torch; (11) *flumen*, a river; (12) *lapis*, a stone; (13) *tectum*, a roof; (14) *flamen*, a priest; (15) *funis*, a rope; (16) *calx*, a heel; (17) *rupes*, a rock; (18) *mulier*, a woman; (19) *latro*, a robber; (20) *ala*, a wing. Each word together with its meaning in English was printed in large type on a separate card; and this card was shown to the subjects for 30 seconds. A fixed sequence was observed—the sequence given above. The first class dealt with was shown “*hiems* = winter” for half a minute, then the next card, “*gladius* = a sword” for another half-minute, and so forth all through the series. Then the Latin words only were written on the blackboard, in an entirely different order from that in which they were learnt, and the children were required to write them down and add their meanings. Without further revision, and without warning, the children were tested in the same way 24 hours later. It was obvious from the result of this test that certain associations were, apart from their position, much stronger than others. “*mulier*, a woman,” and “*silva*, a wood” for instance, were much more frequently remembered than “*rupes*, a rock” or “*funis*, a rope.” And although there was clear indication that position in the series affected the frequency of correct reproduction, yet irregularities due to the inherent nature of the associations rendered it difficult to see precisely what was due to position only. I therefore continued the experiment with 19 other classes, preserving the same sequence of exposure, except that each class began with a different word. The second class, for instance, began with *gladius*

and ended with *hiems*; the third class began with *spes*, and ended with *gladius*; and so forth. Each of the 20 words therefore occupied each of the twenty possible positions in the order of presentation. Thus any advantage or disadvantage a particular association may have had through the ease or difficulty with which, by its intrinsic nature, it was remembered, was distributed equally throughout the whole series of positions. The elimination of this disturbing element would have been complete but for the variety in the size and ability of the classes dealt with. The total number of children tested was 888. The average age was 12 years one month. The greatest care was taken to prevent copying, collusion, or revision among the subjects. None of them knew any Latin, and it is not likely that any of the meanings of the Latin words suggested themselves by English derivatives. The results were calculated for each individual child, and for each individual word. It was thus possible to check the total results and to revise the marking and the records until the totals balanced.

The summarised results are given numerically in Table XX, and diagrammatically in Fig. 3.

TABLE XX.

Order of exposure	1st test	Forgotten next day	Recovered next day
1st	659	28	75
2nd	532	30	105
3rd	453	28	111
4th	332	49	87
5th	323	39	120
6th	291	24	122
7th	281	20	110
8th	250	19	120
9th	267	30	106
10th	264	38	123
11th	263	33	111
12th	262	26	132
13th	248	22	125
14th	282	32	125
15th	273	36	92
16th	298	35	114
17th	313	39	89
18th	302	34	98
19th	337	31	99
20th	401	38	102
Total	6631	631	2166

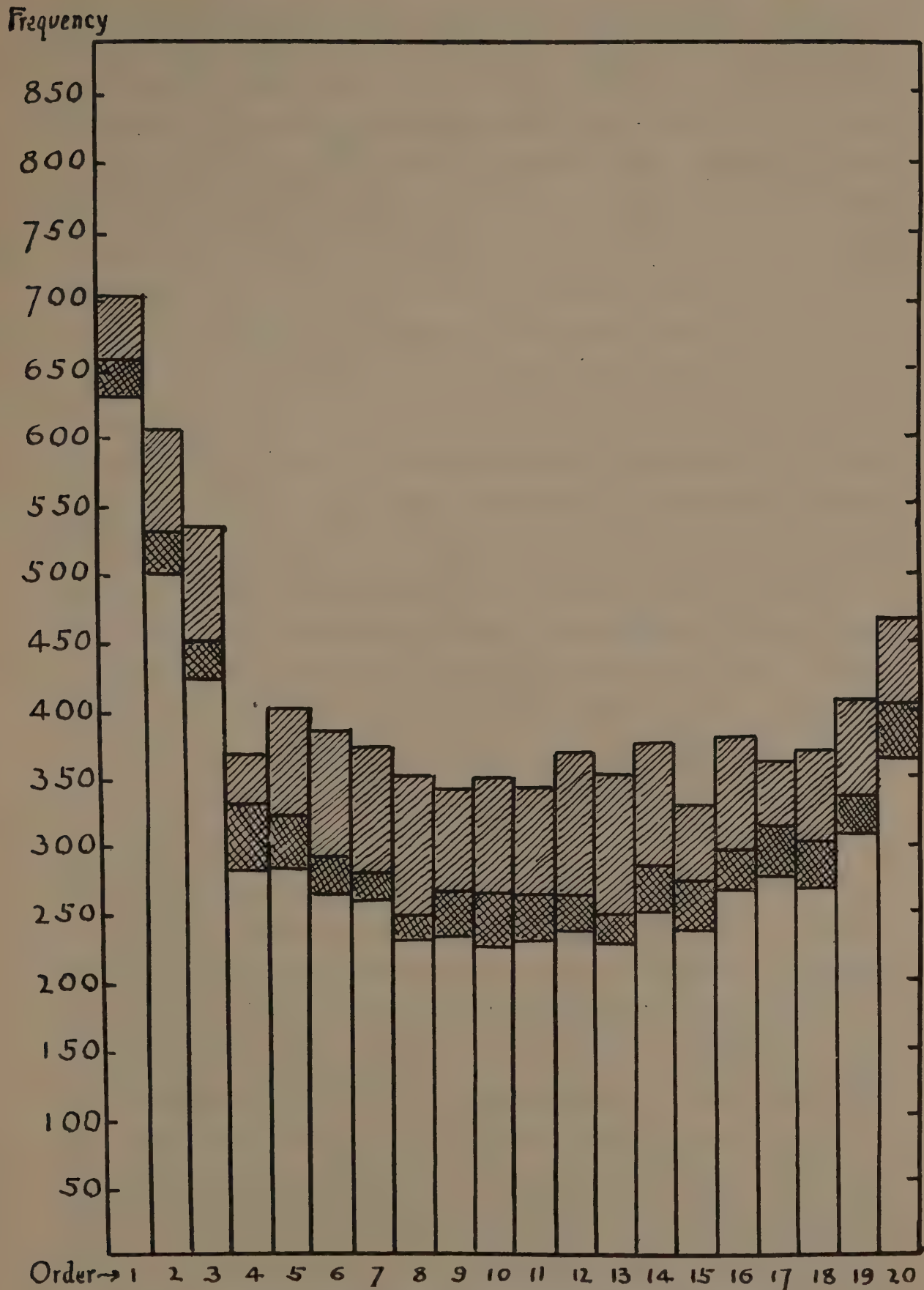


Fig. 3. Retention, Obliviscence and Reminiscence as influenced by the order in which the members of a series are presented.

Each of the 20 classes did better after a day's interval than immediately after learning. The meaning of each individual word was on the whole remembered better at the second test than the first, although there were a few rare exceptions for individual classes, and several exceptions for individual children. The significance of the results is best seen in Fig. 3. A column reaching to the top of the chart would imply that the meaning of the particular word in that position was reproduced correctly by all the children tested; so the height of the column as compared with the height of the chart gives the ratio of the actual to the possible frequency of accurate recall. There are three levels to each column. The middle level represents the frequency of correct recall immediately after memorising; the highest level the frequency on the next day, and the lowest level the frequency with which the meaning reproduced correctly on the first day was also reproduced correctly on the second day. The unshaded part of the column therefore represents retention; the darkly shaded part obliviscence, the lightly shaded part gain or improvement, and the whole of the shaded part, both light and dark, reminiscence. Whichever of the three levels is considered the following statements hold good. The most favourable position in a series for remembrance is the first; the next is near the beginning (the 2nd or the 3rd in the series); and the next is the last. The least favourable position is at or near the middle. This accords with the findings of other experimenters¹.

It may be pointed out, however, that the Latin words and their meanings were not learnt as members of a series, but as isolated pairs of associated words. Nor were they tested in the order in which they were learnt. I call them a series because they were presented in a definite prearranged temporal order. The new data to which the attention of the reader is invited consist of the amount and distribution of the obliviscent and reminiscient elements. On the average 9·5 per cent. of the items remembered on the day of learning were forgotten the next day, and 32·6 per cent. were recovered. And both the forgotten and the recovered or reminiscient items were fairly well distributed over the series. It is true that reminiscence was on the whole greater near the middle of the series than near the ends, but this was what might have been expected on the ground of mathematical probability. Let us compare for instance the highest degree of reminiscence with the lowest. The first member, the lowest, was recovered 75 times, and the 12th, the highest, 132 times. But since the first member was reproduced

¹ See *A Text-Book of Experimental Psychology* by Dr C. S. Myers, 1911, i. 150.

accurately 659 times at the primary test, there remained only $888 - 659$, i.e. 229, possibilities of reminiscence; while for the 12th item there were $888 - 262$, or 626, possibilities. But while in the case of the 12th member only 21 per cent. of the possibilities were realised, in the case of the first 32·7 per cent. were realised. This superiority can be accounted for by advantage of position. To put it generally, there is no peculiarity in the distribution of reminiscence over the series which cannot be accounted for without assuming the presence of inhibitions.

Let us now consider what sort of distribution one ought to expect if fatigue were the only factor that conditioned reminiscence. Fatigue may be supposed to act in two ways. In the first place it would diminish the capacity to learn as the series progressed, and in the second place it would diminish the power of remembering what had actually been learnt. It would in fact prevent some results and mask others. If we suppose fatigue to be operative from the beginning and to gather momentum as the learning proceeds, one would expect the tops of the columns to form a curve descending from left to right and convex from above; and after the fatigue had passed away one would expect to find the amount of reminiscence increasing steadily towards the right. Neither of these expectations is realised in the results described.

If, again, retro-active inhibition were the only causal factor, the columns for the primary test would gradually increase from left to right; but since this inhibition soon passes away, the columns for the secondary test ought to be all of the same height. There would be a gradually diminishing amount of reminiscence as the series proceeded from the first to the 20th, with none at all for the 20th column.

It is true that one cannot but believe that a large number of factors actually condition the shape of the curve formed by joining the tops of the columns, and that fatigue and retro-active inhibition, if operative at all, are but two of many factors; but what I wish to emphasize is that if a variety of inhibitions are only temporarily imposed upon the memorised series they are evenly distributed; and it seems improbable that such inhibitions should be so well balanced as to lay all parts of the series under equal disabilities. Indeed the data I have presented render it incredible that the removal of such inhibitions as arise from fatigue, excitement or other causes, is responsible for more than a comparatively insignificant part of the reminiscence that supervenes.

We have therefore to consider the alternative supposition that reminiscence is due to some sort of cerebral change that requires time

to mature. The difference between the two theories resolves itself into the distinction between something that is complete but cannot act because something else is stopping it, and something that is not in itself complete until some time has elapsed. We have to decide whether in the case of lost memories afterwards recovered the conditions of revival were present at first, but neutralised by other conditions; or whether the positive conditions of revival were not completely present until later on.

II. *Neural growth that continues after the process of learning has ceased.* It is, as I have already stated, impossible to believe that the whole, or indeed the bulk, of the phenomena that might be brought under the head of reminiscence can be explained merely on the ground of the removal of inhibitions formed during the process of learning. Even if the natural inertia of the nervous system—the resistance it offers to change—can in any sense be regarded as an inhibition, it is not an inhibition generated during the process of learning. And I think it can be shown that this concept of neural inertia unifies the phenomena with which we are dealing. Indeed the notion of neural plasticity as forming the physical basis of habit seems to involve that of inertia. William James defines the word thus: “Plasticity then, in the wide sense of the term, means the possession of a structure weak enough to yield to an influence, *but strong enough not to yield at once*¹.” Extend the notion so as to include the inertia of motion as well as the inertia of rest and we get a broad concept which seems to cover all the facts of memory and reminiscence, so far as they can be reduced to physical laws. The belief that the change that takes place in the nervous system during conscious learning is to a certain extent continued when the learning has ceased is forced upon us when we consider those phenomena of reminiscence in which the physical basis is marked and manifest. If skill in swimming, skating, dancing, typewriting, piano-playing etc., is developed during a rest when no practice at all takes place (and that this is so has been abundantly demonstrated), some changes—and changes for the better—must during that period be going on in the traces or dispositions left by practice, and it is highly improbable that this development consists merely in the removal of obstructions and hindrances which arise during practice. And in all memorising, certainly in the memorising of poetry, the physiological factor—the motor-habit factor—is apparent. Evidence favourable to this notion of a registration of our experiences in our nervous system, and particularly

¹ *Principles of Psychology*, I. 105.

the notion that this registration takes time to accomplish and takes place when the mind is occupied with other things, is afforded by a well-known article by Dr W. H. Burnham on "Retro-active Amnesia¹." As he points out, it often happens that when a man is rendered unconscious by a severe blow on the head, or by some other means, he forgets after recovery, not merely what took place during his period of unconsciousness, but also—and this is the important point—what took place at the time of the accident and for some minutes or even hours before the accident. Dr Burnham explains this by assuming that the registration of the forgotten experiences was cut short by the blow on the head, and the physical conditions of recall were consequently lacking.

What then is the nature of this registration? It seems clear that we have it in an intensified form in the acquisition of a habit. Although the doctrine that memory is nothing more than a network of habits is highly questionable, it is in no way doubtful that habit is an important element in every concrete act of memory. How else can the improvement brought about by repetition be explained? The objection that memory may be indelibly fixed by one mental operation while the very essence of habit-formation consists in repetition, fails to meet the case. For apart from the fact that the unforgettability of an experience is only evidenced by its recurrence in consciousness, it may well be doubted whether repetition is essential to habit-formation. If a_1, a_2, a_3, a_4, a_5 , etc. signifies the repetition of a certain act a which ultimately leads to the fixation of a habit that becomes virtually automatic, it is clear that a must have contributed something to that result. By a concentration of attention and effort it is generally possible to abbreviate the series; and we are then forced to believe that each act (including the first) effects a bigger neural change. And it is at least theoretically possible to reduce the series to the limiting case of one act. At any rate the single act always contributes something. Mr B. R. Andrews is quoted by Dr S. H. Rowe as holding a somewhat similar view². "A mental experience of great intensity or interest results without repetition in a strong habitual tendency." "A great flood in a single day tears out a path which a smaller stream would take years to form." Dr Rowe comments on this by contending that the analogy breaks down, because, although the result may appear the same, there is, until the experience has been established through repetition, a lack of the facility involved in habit. I contend however that my experiments prove that increased

¹ *Amer. J. of Psychol.* No. 14, 118—132.

² *Habit Formation and the Science of Teaching*, 1910, 160.

facility does take place as the result not merely of repetition, but also of a process which goes on while the conscious mind is busy with matters unconnected with that process.

It is in experiments in the formation of habit and the acquisition of skill, therefore, that we are likely to find the clue we are seeking. How are we to explain the improvement in motor skill that appears after an interval of rest? Two hypotheses have been suggested. One assumes that there is an actual deepening and fixing of the successful neural paths during the period of rest; the other that all the paths of discharge, both those which lead to the successful performance of the act and those which do not, suffer equally a process of decay, and the fainter paths (those of failure) soon disappear, leaving the paths of success free from competition. The latter hypothesis may be illustrated by supposing that the strengths of the various traces are represented by the numbers 1, 3, 2, 9, 4, 1, 2, of which 9 is the strength of the successful trace. If these numbers were reduced by one each day, at the end of 4 days the number 5 would alone be left. It is thought that the loss through the fading of the brain tracks is more than compensated for by the disappearance of divergent paths.

This theory, plausible enough in accounting for the acquisition of a new act of skill such as swimming or dancing, although even here it seems to me to be inadequate, fails to explain the reminiscence that took place in the experiments in memory which I have been describing. For the analogy between the two processes is far from complete. In learning to dance, the method of trial and error is inevitable; attention is directed not to the separate muscular contractions but to the success or failure of the physical result; and many unsuccessful efforts, which must leave some impress on the nervous system, cannot be avoided. In memorising poetry on the other hand each step is under the guidance of ideas, and as a rule no wrong associations are established during the process. The mere fading out of the wrong cannot therefore account for the improvement. It can be due to nothing else than the strengthening of the right.

We are led to the same conclusion when we consider what happens when we recover the memory of a tune heard once. It is a matter of common experience that a new tune goes through a sort of incubation process in the mind. It may be some days before it is completely 'hatched.' Are we to believe that while listening to the tune there are formed certain erratic associations which tend to lead one on the wrong track when attempts are made to recall the tune; and that the recovery

of the tune is merely due to the fading of the misleading associations? The theory recognises a greater potency and stability in the right series of associations; else why should this series not disappear with the disappearance of the others? This being so, why should not the tendency to pass along the right paths be always stronger than the tendency to stray? It is indeed almost impossible to believe that the right brain paths were completely formed immediately the perceptual experience had ceased. We are driven to assume an actual deepening of the impression after the original cause had ceased to act. It seems as though time and nutrition were necessary for the nervous system to take on in full the trend or 'set' imparted to it by the original experience.

There is one outstanding fact that has persistently forced itself upon me all through this inquiry, and has not yet been brought into accord with my general principle of explanation. It is the fact that, as a general but not an invariable rule, when the learning takes place in the afternoon (especially if it be late in the afternoon) the amount of reminiscence that follows is greater than when the learning takes place in the morning (especially if it takes place early in the morning). For purposes of reminiscence, the later in the day the learning takes place the better. When I first observed this fact I ascribed it to fatigue, and I worked on that hypothesis for some time. Two features of these afternoon experiments, however, did not fit in with the theory and caused me much perplexity. First, the amount learnt in the afternoon did not materially differ from the amount learnt in the morning; and, secondly, the disadvantageous circumstances of the primary test—if they were disadvantageous—were repeated at the secondary test. For the secondary test was also set in the afternoon. If the fatigue of the day's work prevented the children from doing themselves justice at the primary test, it would also prevent them from doing themselves justice at the secondary test. In fact the fatigue theory (which broke down in other applications as well) had ultimately to be abandoned. If indeed the phenomenon in question is to be explained at all on the ground of the removal of inhibition, it is more probable that it is of the retro-active kind, and similar in character to that met with in certain experiments of Müller and Pilzecker, thus described by Dr Myers¹. "Four series of twelve syllables, which we may term *A*, were read eight times by the subject who thereupon, before being tested, proceeded to examine a set of three pictures closely enough to be able to undergo a catechism as to their contents. Four like series of twelve syllables, which we may call

¹ *An Introduction to Experimental Psychology*, 81—82.

B, were read a like number of times, but the like interval between learning and testing was made as restful as possible. The percentage scored for *A* and *B* turned out to be 24 and 56, the average scoring times 2.95 and 2.49 seconds respectively."

It will be observed that Dr Myers follows Müller and Pilzecker in ascribing this remarkable result to the passing away of retro-active inhibition. For reasons which I have already given I am inclined to the belief that it is due to organic registration. The close examination of the pictures absorbs mental energy which would otherwise have been engaged in carrying out the cerebral changes necessary for the organic fixing of the syllabic associations. However that may be, the fact remains that the retention of what is learnt is affected by the amount of mental work done by the subject immediately after learning. When poetry was memorised early in the morning session, severe mental work usually followed, while the complete rest that comes with sleep was far off. When, on the other hand, the memorising took place the last thing in the afternoon, the mental work of the day was over (for home-work is not compulsory in Elementary schools), and the time for sleep not very far off. Thus greater opportunity for continuing and fixing the cerebral modifications that had taken place was afforded in the latter case than in the former. Whatever the nature of the neural machinery which underlies motor or physiological memory, that machinery cannot instantaneously be set up in perfectly smooth working order. Even many repetitions of the act are ineffective, apart from the time necessarily involved in such repetitions. It is impossible at one sitting to learn a long series of words so as to repeat them without thinking, as one can repeat the multiplication table. For the facile working of motor memory, time is necessary.

Assuming some such organisation of the physiological dispositions as has been described in dealing with psychical dispositions, we shall proceed to consider the matter from the point of view of the limitation of cerebral energy available within a given time. The physical traces concerned in reminiscence are of two kinds, those that are initially effective and those that are subsequently effective. The former I will call *A*, and the latter *B*: together they form the system concerned in producing the phenomena. It is certain that between the primary and secondary reproduction a reminiscient change has taken place in *A*, a change which shows itself in increased facility of recall. Is it possible to explain the other facts without assuming a similar change in *B*? We may assume that, at the primary attempt to recall, the cerebral

energy then available was used up mainly in effectively exciting *A*. At the secondary attempt less energy was necessary to excite *A*, and more was therefore available for the excitation of *B*; and the successful recall of the corresponding ideas might accordingly be due not to any previous change in *B*, but to the fact that more energy was expended in exciting it. In other words, according to this view the real reminiscence—as a process which arrests and opposes obliviscence—takes place in *A* only. But this supposition is not in accordance with the fully-attested fact that the forgotten items frequently emerge spontaneously in consciousness. I need only refer to the case of the temporally forgotten name of an acquaintance. To try to recall it (that is to excite *A*), sets at work some sort of mental machinery which hands in the desired name after a short lapse of time. Here there has been no further excitation of *A* before *B* becomes effectively excited.

M. Henri Piéron believes that much light may be thrown upon the question of neural setting by an experimental study of the lower animals directed towards finding the most effective interval between successive stimulations when more than one is necessary to produce a desired result. He himself carried out a series of experiments on the pond-snail¹. It seems that if a snail be exposed for a while to a light of fixed intensity and the light be suddenly obscured, the snail will react by a characteristic movement of withdrawal. If, however, the obscuration be repeated several times the reaction will cease to take place. The snail has learnt the fact that the sudden darkening is a false alarm. With intervals of ten seconds between the obscurations, it was found by M. Piéron that about eleven obscurations were necessary to teach the snail its lesson. After a few hours' time however, the lesson was entirely forgotten and a series of eleven obscurations was again necessary to bring about a cessation of the act of withdrawal. But when the snail was tested after a lapse of time less than two hours and more than ten seconds it was found that less than eleven obscurations were needed. Some of the past experience was remembered and some forgotten; and the amount retained was estimated by the 'saving' method of Ebbinghaus. It was found in fact that by eleven repetitions, provided the interval between the repetitions was regularly ten seconds, the pond-snail could learn a simple lesson; but its memory was so short that it immediately started forgetting it, and after a few hours had forgotten it altogether. M. Piéron then set himself the task of discovering the effect of altering the intervals between the stimuli,

¹ *C. r. Acad. d. Sci.* 1909, CXLIX, 513—516; 1911, CLII, 1115—1118 and 1410—1413.

and he found that when the intervals were less than five seconds, or more than 20 seconds, a larger number of obscurations was necessary in order to stop the snail's reaction. In other words the most favourable interval between the stimuli was somewhere between five and twenty seconds.

He further experimented on two human subjects, one of whom memorised figures and the other nonsense syllables, the 'whole,' as distinct from the 'sectional,' method being used. His statistical results are scanty and do not clearly reveal the best distribution of readings. The most favourable interval is however more than ten minutes and less than 48 hours. M. Piéron gives 24 hours as the probable period.

He rejects the fatigue hypothesis as a principle of explanation, for in the case of the snail at least there is no evidence of fatigue, since it continues to react normally to other stimuli; and he adopts the alternative theory that memorial traces require time for their formation. He goes on to infer that the time required is represented by the most favourable interval between the stimuli.

His summing up is as follows: "Nous croyons pouvoir conclure qu'il existe bien une période de fixation des traces mnémoniques se poursuivant après la fin de l'excitation sensorielle, période de durée très variable suivant les espèces animales.

"En outre, il semble qu'il ait un rapport entre la rapidité d'évanouissement et la durée de la période d'établissement, l'oubli étant plus lent quand la fixation elle-même a été plus lente¹."

The writer accepts M. Piéron's view, with certain reservations as to the exact meaning to be attached to some of his phrases. It is clear from the general trend of his arguments that the term "traces mnémoniques" refers to physiological rather than to psychological dispositions. But what precisely is meant by the establishing of these traces? Assuming that the postulating of brain traces suffices to account for primary or immediate memory as well as for deferred memory, we have yet to determine what is the difference between a trace that is fully established and a trace that is not fully established. The essential characteristic of traces is that they serve by their excitation to revive an experience, and their efficacy may be measured by the readiness and faithfulness with which they perform this task. Judged by this standard there is no difference between the traces which enable me to recall a phrase I first heard thirty years ago and the traces

¹ "Sur la détermination de la période d'établissement dans les acquisitions mnémoniques." *C. r. Acad. d. Sci.* 1911, CLII, 1413.

which enable me to recall a phrase I first heard five minutes ago, provided both recollections are equally facile and faithful. So far as mere immediate efficiency is concerned there is nothing to choose between them. And yet it is possible to demonstrate that between the two sets of traces there is an enormous difference in stability, in power to resist obliviscence, in subtle relationship to other traces, and in liability to reminiscence. The gradual passage of the unstable kind into the stable kind is what Burnham calls organic registration, and Piéron the establishment or fixation of memorial traces. Of this fixation two characteristics may be pointed out. First, we can set no time limit to the process: it is doubtful whether it ever ceases, so long as the brain continues to function normally. Secondly, such neural setting is not in itself sufficient to account for the phenomena of reminiscence, or for the phenomena attested by M. Piéron. The outstanding fact that calls for explanation is that some of the memorial traces improve in efficiency during the early stages of the process of fixation. And this seems to require the added concept of neural inertia. There is not merely a consolidating of the effect produced during the original experience: there is an actual increase in the effect itself after the generating cause has apparently ceased to act.

If on the other hand we interpret "*la période d'établissement*" to mean the early part of the period of neural setting—that part during which an improvement in immediate efficiency takes place—we again find the theory at variance with fact. A simple theory of a fixed period for the maturation of all memory traces in the same subject, followed by another period of decay, is applicable neither to individual traces nor to systems of traces. The period of maturation, of improvement, varies enormously with the individual bonds of association, and, in many instances, does not seem to exist at all. The theory fails to account for the obliviscence that takes place before the so-called fixation period is over.

Suppose we conclude that M. Piéron means by the period of fixation precisely what I mean by the interval for maximal reminiscence. It seems reasonable to assume that the best interval between the readings necessary for memorising is that which represents the greatest surplus of gain over loss—the interval at the end of which the excess of reminiscence over obliviscence shows the greatest balance to the good. This coincidence of meaning is apparently true for children; for with them the point of maximum improvement is the same as the point of maximum reminiscence. In dealing with adults, however, we seem to

be placed in a quandary. So far as our experiments go there seems to be no period during which the memory of adults on the whole improves. It is not impossible however that if they had been tested with intervals of less than 24 hours the memory curve would have shown a slight rise. Indeed the interval suggested by M. Piéron was less than 24 hours.

The truth is, however, that in rendering certain intervals between the readings more favourable than others there are more factors operative than any single one of the suggested theories would cover—maturation and fixation, reminiscence by facilitation and reminiscence by increase in the amount reproducible, the rate of obliviscence, the passing away of inhibitions, and so forth. The period ends in a favourable balance of various tendencies.

M. Piéron's remark about the variation of the length of the period with the species of animal is well supported by the results of his experiments. It should however be added that the period also varies with different individuals of the same species and with different ages of the same individual.

My own researches broadly confirm the view that there is a relationship between the rate of obliviscence and the length of the most favourable period. The younger children, who were shown to forget less readily than older children and adults, were also shown to be capable of reminiscence greater in amount and extending over a longer period.

Putting forward therefore as explanatory principles the concepts of neural inertia and of a positive change in the character of all the physiological dispositions concerned, we find that all the facts of reminiscence fall in with our general theory.

A child remembers more after the lapse of time because the improvement due to neural 'setting' has outpaced the decay which accompanies obliviscence. The effect of repetition is greater on associations a few days old than on those a few minutes old¹ because the older associations have meanwhile gathered strength. A wide distribution of repetitions is better than concentrated repetitions for the same reason. Rest after memorising is favourable to retention because there is a minimum of diversion of cerebral energy from the work of registering the experience. The recall of a part of a poem serves as a stimulus to the recall, after a lapse of time, of the rest of the poem, because the excitation of one part of the underlying system of cerebral traces has extended to the other part; and although the excitation of the latter was insufficient to produce actual revival, it was sufficient to set up that sort of gradual

¹ See Dr Myers's *Text-book of Experimental Psychology*, I. 162—169.

strengthening which gives rise to subsequent reminiscence. So also in the attempt to recall old experiences. Reminiscent activity is set up in dispositions inter-related with those which were actually effective. It may generally be stated that when the excitation of part of a system of dispositions is effective in producing a revival of the corresponding mental states, reminiscent activity is set up in the whole system. It shows itself in the part previously effective, by greater facility of recall: it shows itself in the part previously ineffective, by rendering it at least partially effective.

If we wish to treat the matter from the point of view of the drainage theory of inhibition and the doctrine of synapses as set forth by Mr McDougall in his "Physiological Psychology," we have merely to paraphrase our general conclusions. Reminiscent activity would then mean a gradual and unobtrusive lowering of the resistance at certain synapses, as distinct from the more sudden and manifest lowering that takes place when learning or recapitulation is going on. Instead of assuming that, at the forgetting stage which precedes reminiscence, the permeability of the synapses involved is the same as at the later stage, and only seems less because the synapses are fatigued or because the neural current is drained off into divergent channels, we would rather believe that there goes on some real change of brain structure which slowly and slightly increases the permeability of these synapses.

SUMMARY.

1. When a young child has imperfectly memorised a passage of poetry, he is, as a rule, able to remember more of it after the lapse of a few days than he does immediately after learning, although he has in the meanwhile had no opportunity for revision. This improvement takes place even when he does not think of the poem at all in the interval between the two tests.

2. The amount of improvement manifested depends to a large extent upon the poem memorised. The more comprehensible it is to the child, and the more it interests him, the greater is the amount of improvement. It is not necessary, however, that the verse should be meaningful; for nonsense words, if they are alliterative and rhythmical, show the same improvement in reproducibility.

3. The degree of improvement varies considerably with the age of the subject. As a general rule, children of six years of age improve to the extent of 50 or 60 per cent. in two days; children of twelve improve

from 10 to 20 per cent.; subjects over 20 years of age do not improve at all. These are average figures derived from classes of about 40 children. Individuals differ enormously.

4. If the number of subjects who at a given test show improvement is considered instead of the improvement in the aggregate score of the subjects, the same kind of difference is manifested. Nearly 90 per cent. of infants improve, about 75 per cent. of older children, and about 30 per cent. of students at a training college.

5. Not merely is there an increase in the amount reproduced after the interval, but there is also an increase in the facility of reproduction. Although more is repeated, less time is taken for repetition. The percentage of children who manifest this kind of improvement is higher than that of those who show improvement in quantity. Indeed it exceeds 90 per cent.

6. The improvement in the quantity reproduced is accompanied by a forgetting of some of the material initially remembered. In other words, both obliviscence and reminiscence occur together. There has been both a loss and a gain; and the total amount reproduced after the interval represents the balance.

7. Reminiscence, or remembering, is generally manifested by one or more of a small group of subjects taken at random. Among all the classes tested, and they amount to over 300, no class was found where reminiscence did not take place at all. Over 80 per cent. of the individual subjects tested gave evidence of the capacity; and this is true of training college students as well as of children in the elementary schools.

8. Although not to the same degree, every kind of memorised material is liable to reminiscence, just as every kind is liable to obliviscence.

9. At six, twelve, fifteen, and twenty years of age, subjects tested with ballad poetry show as a rule about 50, 20, 15 and 10 per cent. reminiscence respectively. The absolute number of lines recovered, however, increases up to early adolescence and then gradually diminishes.

10. The interval for maximal reminiscence is about two days. When the intellectual element predominates the interval tends to be shortened; when the motor element predominates it tends to be lengthened.

11. Subjects who casually think of the passage of poetry during the interval between the two tests show slightly more reminiscence than those who do not.

12. Reminiscence is more active among old and consolidated associations than among those recently established.

13. A *systematic* attempt to recollect has a very marked effect on the amount of reminiscence that supervenes. This stimulating effect of the effort to recall is very much greater upon knowledge a few days old than upon recently acquired knowledge.

14. Judging from the results of a variety of tests and from the introspective evidence of the subjects experimented on, there is no particular type of sense material or of imagery which exclusively or even predominantly participates in the process of reminiscence.

15. The relation between reminiscence and general ability is somewhat complicated. Among mentally defective children the amount recovered bears an exceptionally high ratio to the amount initially learnt. The latter, however, is small. Generally speaking, among children of the same age the more intelligent learn faster, retain better, and recover more than the less intelligent. The latter however show a higher *percentage* of recovery or reminiscence.

16. If we adopt the theory of psychical dispositions as a principle of explanation, the reminiscence that immediately follows memorising may be said to be due to a prolonged subliminal excitation of the dispositions concerned. The reminiscence that follows the partially successful recall of a memorised system may be explained as due to the propagation of the excitement from part to whole. Whenever dispositions are welded into a system, if part of the system is rendered effective—if, that is, it brings its memorial correlates into consciousness—the excitability of the ineffective part of the system will subsequently be increased.

17. It is a conceivable hypothesis that reminiscence arises from the removal of inhibitions which occur during the process of learning or during succeeding mental work. Possibly fatigue is an operative factor. It is significant that the most fatigable of the subjects experimented on showed the highest percentage of reminiscence. More reminiscence, too, followed afternoon learning than morning learning. During the second half of the memorising period less is learnt than during the first half, but more is subsequently recovered.

There are however serious objections to the fatigue theory. (a) The supposed fatigue is not detected when independent tests are employed. (b) Fatigue normally passes away after a night's rest: reminiscence takes at least two days to reach its fullest development. (c) While the amount of fatigue probably increases with the amount of time spent in learning, the amount of subsequent reminiscence does not so increase.

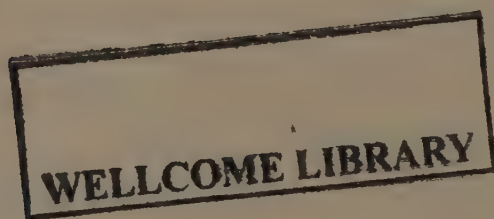
(*d*) The removal of fatigue fails to account for the reminiscence that follows an attempt to recall a poem learnt a few days before. (*e*) It also fails to explain the peculiar reminiscent effect of brooding over old experiences.

18. The passing away of retro-active inhibition—of the disability imposed by the subsequently learnt upon the previously learnt—may partly account for reminiscence; but as an all-embracing principle it is open to the same sort of objections as the fatigue theory.

19. The inhibition hypothesis is further discredited by the results of an investigation into the reminiscent effect of position in a memorised series. The disabilities that appear immediately after learning also appear after the lapse of a few days; and the recovered elements are generally speaking evenly distributed over the series.

20. The alternative theory of neural growth, or of some positive brain change, seems more in accordance with the facts of the case. It assumes that an actual modification of brain structure, of the same nature as that which is supposed to occur during learning, gradually goes on during the interval between the tests.

Reminiscence may be said to be due to the inertia of the nervous system, which does not yield to an influence at once. Nor does the inertia stop yielding at once. Evidence of this positive change is afforded by the phenomena of retro-active amnesia, and by the increase of skill in bodily activities that takes place during long periods of intermission of practice. While it is admitted that many of the facts seem to fit in with either the theory of inhibition or the theory of neural growth, it seems to the writer that the latter is the only theory that adequately explains the whole of the phenomena with which we have been dealing.



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